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CONTENTS OF VOLUME VII.

PAGE

TRIGGERSON, C. J.—A Study of Dryophanta Erinacei (Mayr) and its Gall.... 1

CHILDS, LEROY—The Anatomy of the Diaspinine Scale Insect Epidiaspis Piricola (Del Guer)..... 47

GILLETTE, C. P.—Some Pemphiginae Attacking Species of Populus in Colorado 61

ZETEK, J.—Dispersal of Musca Domestica Linne..... 70

HOUSER, J. S.—Conwentzia Hageni Banks..... 73

MOORE, WM.—A Comparison of Natural Control of Toxoptera Granimum in South Africa and United States..... 77

HOWARD, L. O.—Report on Parasites..... 86

FERNALD, H. T.—Notes on Some Old European Collections..... 89

MACGILLIVRAY—Proceedings of the Atlanta Meeting..... 97

FORBES, WM. T.—A Structural Study of the Caterpillars; III, The Somatic Muscles..... 109

WELCH, PAUL S.—Observations on the Life History and Habits of Hydromyza Confluens Loew, (Diptera)..... 135

CRAWFORD, J. C.—Some Species of the Bee Génus Coelioxys..... 148

TOWNSEND, CHAS. H. T.—Connectant Forms Between the Muscoid and Anthomyioid Flies..... 160

PETRUNKEVITCH, ALEXANDER—Spiders Collected by Mr. C. William Beebe in Burma and Borneo..... 169

SEVERIN, HENRY H. P., SEVERIN, HARRY C., HARTUNG, WM. J.—The Ravages, Life History, Weights of Stages, Natural Enemies and Methods of Control of the Melon Fly (Dacus Cucurbitae Coq.)..... 177

PALMER, MIRIAM A.—Some Notes on the Life History of Ladybeetles..... 213

ALEXANDER, CHAS. PAUL—On a Collection of Crane Flies (Tipulidae Diptera) from the Fiji Islands..... 239

GAHAN, A. B.—A New Species of Cheiloneurus with a Key to the Described Species from the U. S..... 247

TOWER, DANIEL G.—Note on the Number of Spiracles in Mature Chalcid Larvae..... 249

NOYES, ALICE AYR—The Biology of the Net-Spinning Trichoptera of Cascadilla Creek..... 251

MOSHER, EDNA—The Classification of the Pupae of the Ceratocampidae and Hemileucidae..... 277

BLOESER, WM.—Notes on the Life History and Anatomy of Siphona Plusiae.. 301

NEWCOMER, E. J.—Some Notes on Digestion and the Cell Structure of the Digestive Epithelium in Insects..... 311

BAUMBERGER, J. P.—Studies in the Longevity of Insects..... 323

MCGREGOR, E. A.—Four New Tetranychids..... 354

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ANNALS

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A STUDY OF DRYOPHANTA ERINACEI (MAYR) AND ITS GALL.*

C. J. TRIGGERSON.

CONTENTS

1. Introduction.
2. The Life-History of Dryophanta erinacei.
   A. The agamic form.
   B. The sexual form.
3. The Parasitic and Inquiline Life of the Gall.
   A. Breeding Experiments and their Results.
   B. Parasites and their Relation to the Agamic form of Dryophanta erinacei.
   C. Inquilines, their Relation to Dryophanta erinacei, to the Parasites, and to each other during Gall Formation.
4. The Stimulus to Gall Production.
   A. The Relation of the Malpighian Vessels to Gall Formation.
   B. The Relation of the Oenocytes to Gall Formation.
5. Conclusion.
6. Bibliography.

INTRODUCTION.

The Cynipidae constitute, biologically, one of the most interesting families of the Hymenoptera. They have long attracted attention, not only from the systematic view-point, but also from the view-point of their life-history, the variety of the galls they produce or inhabit, their biology, and the cause of gall formation. The purpose of this paper is to present an intensive study of one gall-maker *Dryophanta erinacei* (Mayr), discussing its life-history, its parasites, its guests, and the cause of gall formation.

The Oak Hedgehog Gall is rounded or oblong, with the surface finely netted with fissures, and more or less densely covered with spines. It varies in length from 10-15mm., and occurs on both sides of the White Oak leaf. The point

*Contribution from the Entomological Laboratory of Cornell University.

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of attachment is generally on the midrib (Fig. I, Pl. I), though it is often found on the lateral veins. When young it is yellowish green, but in autumn it becomes yellowish brown, much lighter in color than the tinting of the leaf. The gall first appears late in June, and reaches full development about the third week in August. It is widely distributed, having been reported from New England, North Carolina, Iowa, Illinois, Indiana, Kansas, Michigan, Ohio, Virginia, Canada, and probably Florida and Colorado.

A longitudinal section through the gall shows that it contains several chambers varying from two to eight in number. These I have named according to their location. First to be noted are the *central cavities*, (Fig. 2a, Pl. I), which measure 2mm. x 3mm. and are located in the central portion of the growth. These are occupied by Dryophanta erinacei and the parasites. Second, there are the *lateral cavities*, (Fig. 2b, Pl. I), situated at the side and base of the growth and measuring 1½mm. x 2mm. These are occupied by inquilines. Lastly, there are to be found the *peripheral cavities*, (Fig. 8a, Pl. II), located on the coriaceous portion of the gall, and covered with the basal layer of spines. These are 1mm. in size, and are likewise occupied by iniquilines.

The gall was first described by Walsh in 1864 under the name Cynips q. erinacei. When Mayr in 1881 established the genus Acraspis he included the insect causing this gall, which therefore was known as Acraspis erinacei. The first description of the insect appeared in a paper by Beutenmüller '09, entitled "Species of Biorhiza, Philonix, and their allied Genera, and their Galls," in which he places it in the genus Philonix. As will be shown later in this discussion, the insect belongs to the genus Dryophanta, and should be known therefore as Dryophanta erinacei (Mayr).

The Life-History of Dryophanta Erinacei.

The agamic form of Dryophanta erinacei emerges from the oak hedgehog gall about the fifth of November. It varies from 1.50 to 3mm. in length. The head is black, rufous on both sides of the face, finely punctate, with whitish pubescence; antennae black, fourteen jointed, with basal joints rufous; thorax rufous; plurae black with rufous mark anteriorly; all minutely punctate; parapsidal grooves distinct posteriorly,

obsolete anteriorly; scutellum rufous, punctate and pointed posteriorly; metathorax black; abdomen piceous; ventral spine and tip of abdomen hairy; legs yellowish rufous, tibia slightly darker; wings aborted.

The insect makes its way to the leaf and flower buds of the white oak, where oviposition takes place. On the tree where our observations were made, it continued to emerge and oviposit until the twenty-first of November. The insects are most active on cold days or early in the morning. During the warm weather they are inactive and sluggish, hiding at the base of the petioles, in the crotches of the young shoots, or in the crevices of the bark. They have been taken in this vicinity on rare occasions in early December, but usually they succumb to the first heavy frosts at the close of November.

Its method of oviposition does not differ much from that already described by Kieffer for other species of the Cynipidae which attack buds. The insect clasps the apical portion of the bud with the second pair of legs, (Fig. 3, Pl. I), and pressing alternately with the first and third pair produces a teetering motion which forces the ovipositor into the buds. The long ovipositor lifts the apical edge of the outer scale, and is gradually pressed down along the edge of succeeding scales, and finally thrust into the region of the young leaf and flower. Then there is a sudden jerk of the body which curves the distal end of the ovipositor, turning the openings against the concave face of the innermost scale. The insect now retains a motionless attitude for almost four minutes, during which the egg is deposited. The ovipositor is then withdrawn, the passage being filled with a waxy substance for the protection of the egg. This waxy secretion is doubtless from the accessory glands of the reproductive system, and is homologous with the secretions with which Corydalis cornuta, certain of the Lepidoptera, as the Apple Tent-Caterpillar, the Tussock-moths, and many other insects cover their eggs.

The egg, (Fig. 20, Pl. III), is an oval body 400μ. x 225μ. provided with a pedicel which is 1mm. in length. It is attached by this pedicel to the upper brown portion of the scale, falling either against the green portion of the scale (Fig. 6, Pl. II), or being held among the young leaves or flowers, in which position it remains during the winter. It is worthy of emphasis that this pedicel does not constitute the apical pole of the egg

since the larva emerges from the opposite pole, and as already indicated it serves as an appendage for attaching the egg to the bud scale.

As will be seen later the eggs of the Chalcids are flask-shaped, (Figs. 31, 32 and 37, Pl. IV), but here the elongate portion is in reality the cephalic portion of the egg. This is shown by the fact that the egg is oriented in the ovum in such a way that the elongate portion is cephalad, also that the larva always emerges at the base of the neck (Figs. 32 and 37, Pl. IV). This therefore, is exactly opposite to the condition found in Dryophanta erinacei.

Buds were examined on the eighth of May and the unhatched eggs found were very turgid, appearing slightly enlarged. On the twelfth of May a slight swelling, at the apex of which an empty egg shell was visible, appeared on the lower green portion of the scale, (Fig. 9, Pl. II). This proved to be a freshly formed gall, containing a young larva of Dryophanta erinacei. The gall at this stage was thin-walled, with a pebbled surface, greenish in color, and contained a watery fluid. The egg-shell remains attached to the apex of the gall until the latter has reached considerable size, when it dries up and disappears. These hypertrophies develop rapidly, as many as three appearing on one scale. The wall of the gall has by this time changed to a yellowish brown color, and soon becomes quite dry and brittle.

Galls also develop on the apical portion of the leaf and flower buds, (Fig. 10, Pl. II). These are red, being similar in color to the young leaf and flower. The wall is pebbled on the surface, and thin. The cavity contains a single larva bathed in a watery fluid, and similar in all respects to the one inhabiting the scale gall. The terminal galls are of the same size as those on the scales, varying in number from one to four, and when mature are reddish brown. Since only the agamic form of Dryophanta erinacei was found ovipositing on the leaf and flower buds, and since the eggs of this species and no other were found in the leaf and flower region, and since males and females similar in size and character emerge from the two galls, it is evident that they are produced by the same insect. The difference in color in the galls is due to the normal difference of the tissue of which they are formed.

Shoots were brought into the laboratory, placed in water and covered with bell jars. Here about noon on the twenty-first of May the first male and female emerged. They were quite vigorous, and about four-thirty in the afternoon the female was noticed actively moving along the midrib of the young leaf. Suddenly she stopped, and set up a rapid nodding motion which lasted thirty-five seconds, during which the ovipositor was thrust into the tissue. The insect remained motionless for a time, then withdrew the ovipositor, filling the passage with a yellow substance which, as in the agamic form, is probably a secretion poured forth by the accessory glands of the reproductive system. The process was repeated four times in succession without moving the body forward. Each time the ovipositor was inserted the body was curved slightly more than at the preceding puncture. The entire time occupied by the four ovipositions was from four-thirty-four to four-fifty, or sixteen minutes, thus allowing four minutes to each oviposition of which a little over two minutes and a half was occupied by the passage of the egg. Many other observations were made, and the time in all instances corresponded to the first recorded.

While the first observations of oviposition were made without having seen copulation occur, in all the following instances it was observed. The male strikes the female several times with the antennae, after which the latter rests quiet. The male then clasps her thorax latero-caudad of the second pair of wings with the second pair of legs, while the first pair rest on the dorso cephalic portion of the thorax, and the third pair extend slightly latero-cephalad of the abdomen; copulation takes place, lasting for a few minutes.

The egg of the sexual form, (Fig. 25, Pl. III), is oval, 160μ x 450μ. provided with a pedicel 750μ. in length, which is shorter than in the agamic form. It is always placed in the fibro-vascular bundles, and at an angle of about 80° to the axis of the leaf. The egg differs from that of the agamic form only in the elongate portion being shorter.

The larva is characteristic of the Cynipidae, having a slightly depressed head, fine needle-like mandibles, broad thorax, and reflexed pointed abdomen. During development the abdomen does not become as enlarged as in the agamic form. The thorax also continues prominent throughout all

larval stages, which is not the case with the agamic form. Fig. 27, Pl. III, represents a mature larva of the sexual form, and may be compared with Fig. 19, Pl. III, which represents a mature larva of the agamic form in the corresponding stage.

In the open the adults did not emerge until the twenty-ninth of May, and continued to oviposit from that time until the fifth of June. Oviposition here was as observed in the laboratory, the time occupied corresponding exactly to that already noted. Fig. 4, Pl. I, shows a female of the sexual form.

The sexual form which possesses the characteristics of the genus Dryophanta may be described as follows:

Female: Color. Head, thorax and abdomen shining black, nonpubescent; mandibles yellowish brown; mouthparts yellow; antennae first two joints yellowish, flagellum shading to black at the tip. In the male the entire antennæ are black. Length 2mm.

Head: Face opaque, surface irregular, rugose about the ocelli; compound eyes 200μ.x300μ. Distance between compound eyes and hind ocelli 75μ.; between hind ocelli 100μ.; between compound eyes and fore ocelli 500μ. Distance between compound eyes and antennæ 75μ.; between antennæ 75μ. Width of head at temples 1.50mm.; mandibles tridentate, mouth parts as in Figs. 21, 22, and 23, Pl. III. Antennæ fourteen jointed,(Figs. 28 and 29, Pl. III).

Thorax: Smooth, parapsidal furrows distinct posteriorly, obsolete anteriorly, pluræ smooth.

Scutellum: Rugose, becoming smooth in front, cross furrow reduced to a shallow depression (Fig. 26, Pl. III).

Appendages: Wings hyaline, fringed with setæ, veins yellowish brown, (Fig, 24, Pl. III); legs yellowish, coxæ of the third pair yellowish brown.

Abdomen: Smooth, deeper than long, first segment one-third the size of the abdomen, outline of the remaining segments as seen from the side serrate; ventral spine and tip of abdomen hairy.

Male: Color. Same as female, length 1½mm.

Head:	Distance of compound eyes to hind ocelli	50μ
	" between hind ocelli	150μ
	" of compound eyes to fore ocelli	600μ
	" of compound eyes to antennæ	50μ
	" between antennæ	50μ

Antennæ fifteen jointed.

Thorax: Mesonotum more gibbous than in female.

Abdomen: Petiolated, longer than deep as seen from the side; petiole cylindrical.

On the twenty-fifth of June the first evidences of gall-formation appeared on the leaf-veins, the hypertrophied tissue pushing through the slightly ruptured epidermis. The

embryoes obtained at this stage measured 125μ.–130μ. In galls gathered on the first and second of July, larva were found measuring 374μ. These were similar to the young larva which give rise to the sexual form, having a slightly depressed head, sharp pointed mandibles, broad, prominent thorax, and pointed, reflexed abdomen. During the summer, molts were observed after which the larva measured 500μ, 750μ., 1¼mm., 1¾mm., 2¼mm., respectively, thus showing five stages during the life-history. Fig. 19, Pl. III, shows a larva 1¾mm., obtained about the middle of August. From this time, the thorax does not show a great increase in size, but the abdomen loses its reflexed character, becomes globose, and increases in size until pupation. The first pupa was obtained on the fifth of September, but the adults did not emerge until the fifth of November. Fig. 5, Pl. I, shows a pupa of the agamic form.

Thus we have another illustration of dimorphism in the Cynipidae, the agamic form of Dryophanta erinacei developing in the oak hedgehog gall on the white oak leaves, emerging and ovipositing in the leaf and flower buds of the same tree, from which, in scale and terminal galls, the sexual form develop. These, emerging, oviposit on the veins of the white oak leaves, and their offspring cause the oak hedgehog gall.

The Parasitic and Inquiline Life in the Gall.

The oak hedgehog gall is not merely the abode of the maker, but also of several parasites and inquilines. In order to obtain a knowledge of these, their mode of life, their relationship to the maker, and to each other, we shall consider them under the following heads:

A. Parasitic and inquiline life as shown by breeding experiments.

B. Parasites in relation to Dryophanta erinacei and to each other during gall development.

C. Inquilines, their relation to Dryophanta erinacei, to the parasites, and to each other during gall development.

Parasitic and Inquiline Life as shown by Breeding Experiments.

The breeding experiments were of a twofold character. First, galls were placed in cages, and the species inhabiting them bred out. Second, larva were studied individually in order to obtain larval characters, and then bred out and thereby related to the adults.

I. Leaves bearing galls were gathered, separated from the grass and other leaves, then placed in cardboard boxes at one end of which a test-tube was inserted. In these tubes the insects gathered, and were easily collected. The galls were divided into two classes—those gathered when the leaves were falling from the tree, and those subjected to snow, frost, and general winter conditions for one and two months respectively. The leaves were moistened once a week in order to keep the galls from drying up, and thus preventing the adults from emerging. The parasites appeared first, but the inquilines did not emerge until the last of February.

The parasites, of which eight different species were obtained, belonged to the family Chalcididæ, and were all known to be parasites in the oak galls. The inquilines belonged to the Cynipidæ, genus Synergus. The following table will give the various species, and the number of each obtained.

TABLE I.

Decatoma flava (Ashmead)	600 specimens
" querci-lana-dorsalis (Fitch)	1 specimen
" varians (Walsh)	30 specimens
Eurytoma studiosa (Say)	75 "
" auriceps (Walsh)	30 "
Ormyrus ventricosus (Ashmead)	150 "
Syntomaspis sp.	15 "
Tetrastichus sp.	10 "
Synergus erinacei (Bass.)	70 "

II. The larvæ were removed from the galls, and studied, and the larval characters determined. These specimens were bred out in order to connect with the adult form. The method employed was to note and tabulate such characters as the form of the mandibles, the arrangement and size of the setæ, and the general larval form of a large number of specimens. Each individual was then placed separately in a four dram vial which was sealed and set in a dark place. Four species were bred through to the adult. Both from the study of the larva in the

cavities, and the result of the breeding experiments, it was evident that the parasites inhabited the central cavities, while the inquilines, though occasionally found in this region, were mostly confined to the lateral and peripheral cavities.

Owing to the small percentage of several of the parasites as shown in Table I, we were able to breed out only five species. The descriptions of the larval forms obtained are as follows:

Decatoma flava: The larval form of this Chalcid, (Fig. 34, Pl. IV), when mature measured 1¼mm. It possesses slender bidentate mandibles, (Fig. 33, Pl. IV). The setæ are short and spine-like, arising from distinct, prominent tubercles, and are located as in diagram, (Fig. 42, Pl. V), six on the head, ten on the prothorax, eight on the mesothorax, six on the metathorax, and four on each of the abdominal segments.

The egg, (Fig. 32, Pl. IV), is flask-shaped and measures 200μ.x50μ., neck 560μ., and pedicel 56μ. It is pigmented, and becomes brownish black on maturing. The long neck lies cephalad in the ovary of the adult, and the larva emerges from the egg at the base of the neck, (Fig. 32, Pl. IV). Thus the neck is not comparable to the long pedicel of the eggs of the Cynipidæ. The short, crooked pedicel at the opposite pole represents in atrophied form that found in the Cynipidæ.

Eurytoma studiosa and Eurytoma auriceps: The larval forms of Eurytoma studiosa and Eurytoma auriceps are so similar that it is impossible to determine specific characters. The one shown in Fig. 43, Pl. V, always bred out to Eurytoma studiosa during the winter, but during the summer larvæ corresponding in all respects to the diagram bred out to both Eurytoma studiosa and Eurytoma auriceps. Hence the general characters given here may be considered generic rather than specific. Fig. 35, Pl. IV, gives a general view of this larva.

The mature larva measures 1¼mm., having bidentate mandibles similar to that shown in Fig. 33, Pl. IV. The setæ are long, slender, with distinct tubercles, and give the body a very hairy appearance. The general distribution of these, (Fig. 43, Pl. V), is twelve on the head, ten on the prothorax, ten on the mesothorax, ten on the metathorax, six on the first abdominal segment, four on each of the second, third, and fourth segments, and six on each of the remaining segments. The larva can be readily distinguished from the larva of Decotama flava by the length of the setæ, those of the latter being short, spine-like, and fewer in number.

The egg is flask-shaped measuring 240μ.x144μ., neck 720μ., and pedicel 64μ. The neck lies cephalad in the ovary of the adult, and the embryo emerges from the egg just at the base, (Fig. 37, Pl. IV). The pedicel is short, curved, and aborted. The egg is pigmented and becomes black on maturity. It is quite similar in form to the egg of Decatoma flava, but is slightly larger, and deeper in color when mature.

The egg of Ormyrus ventricosus is flask-shaped measuring 200μ.x 120μ., (Fig. 31, Pl. IV). In this Chalcid egg the pedicel is absent.

Synergus erinacei: The larva of Synergus erinacei, (Fig. 38, Pl. IV) —summer brood—is fleshy, 1mm. in length, and possesses tridentate mandibles, the second tooth of which is pointed like an arrow-head. The setæ are very small, difficult to locate, and without distinct tubercles at the base. Their location, (Fig. 44, Pl. V), is fourteen on the head, fourteen on the prothorax, twelve on the mesothorax, six on the metathorax, four on each of the eight following abdominal segments, six on the ninth, and eight on the tenth segment.

The egg is white, the body being kidney-shaped, 240μ.x80μ., and is provided with a long neck 440μ., Fig. 39, Pl. IV, shows one of these.

The larva of Synergus erinacei (spring brood) is dark, fleshy, 700μ. long, (Fig. 40, Pl. IV). The mandibles are tridentate, the central tooth blunt. The setæ are minute, without distinct tubercles, and distributed as in Fig. 36, Pl. IV, eight on the head, sixteen on the prothorax, ten on each of the meso- and metathorax, eight on each of the first three abdominal segments, and six on each of the remaining segments.

The eggs, two of which are shown in Fig. 41, Pl. IV, are white. The body is kidney-shaped 125μ.x56μ., and provided with a neck 410μ. in length.

Parasites, their relation to Dryophanta erinacei, and to one another during the development of the gall.

The Chalcids, Decatoma flava, Eurytoma studiosa, and Eurytoma auriceps were observed ovipositing from June tenth to the fourteenth. The method in all cases was similar, but the time occupied during oviposition, and the number of eggs deposited differed.

Decatoma flava selected a spot on the midrib where Dryophanta erinacei had oviposited, thrust the long ovipositor down alongside the same channel, and deposited an egg in contact with that of the Cynipid. The ovipositor was then withdrawn, and the opening sealed. This required three minutes.

Eurytoma studiosa and Eurytoma auriceps each selected a spot about the region where Dryophanta erinacei had oviposited, and forcing the ovipositor into the fibro-vascular bundles placed from one to six eggs near, but not in contact, with the egg of the Cynipid. The eggs are usually laid in clusters, and appear black in the tissue of the leaf. The opening is sealed on the withdrawal of the ovipositor. The time consumed by these two species in oviposition was four minutes each.

When the larva of Dryophanta erinacei emerges from the egg, it proceeds at once to form a cavity which encloses the eggs surrounding it. In newly-forming galls the cavity is small, and the egg of the parasites is frequently found resting in

the abdominal angle of the larva of Dryophanta erinacei. Here it often hatches. The larva breaks the shell near the base of the neck, (Fig. 37, Pl. IV.), and emerges, proceeding to attack the host in the abdominal region. If the Cynipid larva has just molted it is destroyed at once. If on the other hand, it escapes the attacks of the parasites during this period, they will live together until the next molt occurs, when the host is almost invariably killed and eaten. Only on rare occasions have the host and parasite been found living together in the same cavity until both have reached 1mm. in length.

If two parasitic larvæ of the same or different species are found in one cavity in the early stages, the stronger alone survives, for I never have observed more than one adult emerge from a single cavity. Since no Chalcid eggs are found in the cavities inhabited by the inquilines, we may conclude that the Chalcids are parasitic primarily on Dryophanta erinacei, and secondarily on one another.

The larva of Eurytoma studiosa and Eurytoma auriceps develop rapidly, and from the twenty-fourth of July to the first of August adults emerge, thus giving a summer brood. No adults of Decatoma flava emerge in the summer or autumn. After the parasites have destroyed the host, it is questionable whether they feed on the plant tissue, since the lining of the cavity they inhabit turns brown, becoming hard and brittle much earlier than is the case with the cavities occupied by Dryophanta erinacei.

It is impossible to determine absolutely the extent of parasitism in these galls, yet we gain some idea from the following. During four weeks 1050 galls were examined, which showed sixty per cent of parasitism not including the internal parasites which had not emerged from the maker.

Inquilines, their relation to Dryophanta erinacei, to the parasites, and to each other during the development of the gall.

The relation of the inquilines of this gall both to the host and to the parasites is very interesting, since they are present not only as guests, but also as parasites. The parasitic character of certain species of Synergus has already been pointed out by Möller and Mann, but nowhere have I found any record of their singular action as observed in this gall. Synergus erinacei is not only parasitic on Dryophanta erinacei, and the parasites

in the central cavities, but it carries its parasitic habits to the extent of mining from cavity to cavity, and having a meal out of the occupants. Fig. 12, Pl. II shows where a larva of Synergus erinacei has mined from A-B, also one is already breaking down the wall at C. Fig. XI, Pl. II shows where a larva of Synergus erinacei has mined from a lateral to a central cavity. In all, over eighty instances of mining have been observed. On eighteen occasions we have fed Dryophanta erinacei and different Chalcid larva to the inquilines, but only once were we able to induce it to attack a larva of its own species. The average time required by Synergus erinacei to consume a larva was 1½ hours. Hence we see that the supposed guest is not only a plant feeder, but has shown itself to be a serious parasite among the occupants of the gall.

The Stimulus to Gall Production.

A. The Relation of the Malpighian Vessels to Gall Formation.

Investigators have generally agreed that galls cannot be produced apart from the presence of insects, but different theories have been presented as to the cause of the abnormal growth. Adler (1881) points out that in Neuroterus læviusclus and Biorhiza aptera, the gall is first caused by the insect wounding the surrounding cells with its fine mandibles, and that the growth of the gall is in some way dependent on the presence of the larva. Cook (1903) in his publication "Galls and Insects Producing Them," states that the Cynipidæ stimulate the plant to excessive growth by biting, and it is his contention that gall formation is primarily the result of mechanical stimulation. Rössig (1904) in a paper entitled "Von Welchen Organen geht der Reiz zur Bildungder Pflanzengalle aus?" attributes a rôle to both oenocytes and the Malpighian vessels, and though regarding the latter as giving off an effective secretion, he attributes the primary source of this secretion to the oenocytes.

His studies of the Malpighian vessels are purely from the morphological standpoint, and are based on a limited and poorly selected variety of species. He places great emphasis on the size of the cells constituting the vessels, and on the size of the vessels as compared with that of the larva. Moreover he includes in his discussion species that do not produce galls by means of any product poured forth by the Malpighian

vessels, since the galls are produced before the eggs are hatched. Finally, he brings no evidence from a broad, comparative study of the Malpighian vessels of various gall-producing species to support his conclusion.

The condition found in the bud-gall from which the sexual form of Dryophanta erinacei emerges is as follows: The egg rests on the living portion of the scale. When the larva emerges a viscous mass is adhering to it, but outside of this is a clear fluid resembling the secretion of the Malpighian vessels both in color and in action on glass when exposed to the air. The young galls soon appear enclosing the larva. In this instance the secretion of the Malpighian vessels appears to provide the first stimulus to gall-formation. With the agamic form, where the egg is enclosed in the plant tissue, one cannot observe the process so easily.

On examining the galls of both the agamic and sexual forms of Dryophanta erinacei, it was noticed that the cavities were lined with growing tissue, abundantly supplied with chlorophyll, also that where the larva of Dryophanta erinacei rested, both it and the plant tissue were bathed at times with a colorless fluid. When the larva was placed on a glass slide it at once poured forth an abundance of this fluid, which always became opaque, milky white, on drying. By varying the position of the larva when placing it on a glass slide, this secretion was seen to pour forth from the anal region, while the head and thorax remained dry. About this time a study of sections of the larva revealed two tubules consisting of four cells each, which showed great activity. Longitudinal sections proved these to be cells of the Malpighian vessels, (Fig. 45, Pl. VI.).

The Malpighian vessels of the agamic form of Dryophanta erinacei consist of two long tubules containing fifty-six rounded cells, with large nuclei, and attached to the hind gut, just at its point of union with the mid-intestine, (Fig. 48, Pl. VI.). They are whitish in color, the cells varying in size according to the larval period. They reach their maximum in the fourth larval stage. These larval tubules do not give rise to the adult vessels, but, degenerating in the prepupal and pupal stages, give place to the adult tubules which arise as evaginations of the hind-intestine, just below the attachment of the larval vessels. They are the largest glands in the body, extending slightly ventrad along the mid-intestine, their cephalic ends

reaching beyond the point of union of the mid and fore-intestine in the region of the thorax, and are held in place by the fat tissue. In a longitudinal section they appear as in Fig. 47 Pl. VI

The individual cells consist of a homogeneous cytoplasm in which vacuoles are found in the outer portion and also near the nucleus. Secretions are sometimes seen in these. The nucleus is irregular, and often greatly branched, sending long arms into the cytoplasm. It is densely packed with chromatin granules.

The larva were mostly fixed in Dietrich's fluid, and stained with borax carmine and Lyons blue. This proved very satisfactory for general work, but the best results were obtained when the larvæ were fixed in hot Gilson's fluid.

The cells are very active in secreting a colorless fluid during the period of gall-formation, which continues from the end of June until the middle of August. At this latter time, the larva has reached the fourth stage, measuring 1¾mm. There is somewhat of an increase in the size of the cells up to this point, which may be in proportion to the demand upon them. After this there is a slight decrease to a constant size, which is retained until degeneration begins. The following table shows the increase.

TABLE II.

	LENGTH	SIZE OF CELLS	
Larva	500μ	64μ.x72μ.	molt.
"	750μ.	64μ.x80μ.	molt.
"	1mm.	72μ.x80μ.	
"	1¼mm.	72μ.x82μ.	molt.
"	1½mm.	72μ.x88μ.	
"	1¾mm.	112μ.x120μ.	molt.
"	2mm.	72μ.x96μ.	
"	2¼mm.	72μ.x88μ.	molt.
"	2½mm.	72μ.x88μ.	

As pointed out earlier in this paper, molts occur at 500μ, 750μ, 1¼mm., 1¾mm., and 2¼mm. It will be observed that the cells reach their maximum at the fourth stage, about which time the gall is rapidly maturing. From this time, less and less secretion is poured out, and the linings of the cavities begin to lose their green appearance, gradually becoming yellowish brown, dry, and hard. Further, the larval form rapidly changes. The abdomen increases in size, becoming globose, while the head and thorax show only small increase. This is in striking contrast to the early stages. A larva of the fifth stage, measuring 2¼mm., when placed on glass or any foreign substance excretes practically no fluid.

It was observed in all early stages that the excretion of the fluid was under the control of the larva, being poured forth freely when required. When a larva was found not feeding on plant tissue the body was dry. When a parasitic larva rested on the host both were bathed in a colorless fluid. If the larva of Dryophanta erinacei was placed on a glass slide or foreign substance, it immediately poured forth an abundance of fluid. It was evident that a reserve must be retained in the tubules. In a longitudinal section, (Fig. 45, Pl. VI.), it will be noticed that the small proximal cells (indicated by *V.*) on each side of the lumen are arranged so as to press closely against those opposite. This formation appears constant throughout the various stages, and we believe has a valvular function.

A number of tubules were dissected out from larva of the earlier stages in normal salt-solution. This solution was allowed to evaporate, and the salt crystals formed used in grinding up the dried tubules. To the powdered mass a few drops of normal saline were added, and when all was dissolved, the fluid was filtered. The filtrate was treated with 85% alcohol, and the action brought down a heavy, white, floculent precipitate, which suggested that something of an enzymic nature might be present. This phase of the investigation was not pursued further at this time.

Fresh material was again obtained, the Malpighian tubules dissected out as above, thoroughly dried, and ground with powdered carborundum, which reduced them to a finer powder than the salt-crystals. The powdered mass was dissolved in a few drops of normal salt-solution and filtered. The filtrate was injected with a hypodermic syringe into the midrib of the white oak leaves, one drop being used to each puncture. The operation was repeated three times on several leaves. Checks were made, normal saline being used in these. The solution containing the Malpighian tubule product penetrated from one-fourth to one-half an inch in the fibro-vascular bundles of the midrib. The tissue was turned yellowish brown, and cracking appeared similar to that seen in many young leaves where the gall formation has just started, but owing to the death of the larva, has ceased. While these experiments did not produce a gall, they give suggestions as to the work performed by the secretion of the tubules. Nothing of the above described appearance was to be seen in the checks.

From a further study of Table II, it will be seen that between the first and fourth larval stages there has been a considerable increase in the size of the cells which constitute the tubules. The greatest increase was between the third and fourth larval stages, which was coincident with the greatest growth of the gall, when it doubled in size. During this period the larva gives off the greatest amount of secretion from the Malpighian vessels. After this time, as already noted, the larval form changes, and the amount of secretion diminishes rapidly, so that a larva taken, say two weeks later, that is about the first of September, would not pour forth any secretion when placed on a foreign substance. The lining of the cavity is by this time quite dry, brittle, and deep yellowish brown in color.

Now, from the development of the Malpighian vessels, and the amount of secretion poured forth by them coincident with the gall development, also in view of the effect of this secretion when applied to the plant tissue in the experiments, it is evident that the Malpighian vessels have elaborated some product which when poured forth by the insect stimulates the surrounding plant tissue to rapid growth. In a few instances, we have found urate crystals in the lumen of the tubules, but urates are present in the Malpighian vessels of all insects, and, as Rössig has shown, chemically pure urates do not produce galls. Hence an additional factor is without doubt present in the secretion of the Malpighian tubules of Dryophanta erinacei, and this produces the effective stimulus.

The Malpighian Vessels of the Inquilines.

The Malpighian vessels of the inquilines were dissected out. They were white in color, and consisted of two slender tubules. These arise at the point of union of the mid and hind-intestine, having a broader attachment than that found in Dryophanta erinacei, (Fig. 60, Pl. VIII). The cells are smaller than those of D. erinacei, the nuclei more regular, and the lumen quite distinct. They show no evidence of great secreting activity, and in a longitudinal section appear as in Fig. 61, Pl. VIII. The larva when placed on a glass slide does not pour forth a secretion as does Dryophanta erinacei. Further, the species, though an inhabitant of a gall, does not emerge from the egg until the gall has attained considerable growth. Its eggs are

rarely found in the central cavities, but generally in the rapidly growing tissue of the gall, where, after emerging, it forms a cavity. Again the summer brood oviposit on the young galls in July, laying their eggs just beneath the soft outer layer. Here on hatching the larva forms a mere depression in the hard portion of the gall, the soft outer layer forming the other wall. It therefore gives rise to no gall formation. We have here, then, a species of the Cynipidæ, an inhabitant of a gall, appearing after the stimulus to abnormal growth has been given, and evidently not contributing to it. Its larval Malpighian tubules are less developed than those of Dryophanta erinacei.

The Malpighian Vessels of the Parasites Inhabiting the Gall.

The Malpighian vessels of a Eurytoma larva, as dissected out, are yellowish in color, larger than those of the inquiline, and four in number. There are two long, clavate tubules drawn to a point at their cephalic ends, and two short ones with blunt ends, (Fig. 62, Pl. VIII). These arise at the union of the mid and hind-intestine. The long tubules extend cephalad slightly ventrad of the mid-intestine beyond the point of union of the mid and fore-intestine in the thorax. The cells are smaller than those of Dryophanta erinacei, the nuclei more compact, and they do not give evidence of a high state of activity. Further, it must be remembered that the black eggs of these parasites are found only in the central cavities, and never in the tissue of the gall. Hence they are in a place where there is no demand for gall formation. Again, the galls are well developed, and the cavities of fair size before these emerge from the egg. Therefore they do not give rise to a chamber, as do both the maker and the inquilines. Moreover when placed on a glass slide or foreign substance they do not excrete a quantity of fluid, as do the larva of Dryophanta erinacei. Finally, when they have destroyed the host, the cavity lining loses its green, healthy appearance, passing from a yellowish brown to a deep brown color.

Now, considering the habits of the parasites—that they do not form a cavity, but occupy one already developed by Dryophanta erinacei, and feed upon this species—also that the cells of their Malpighian vessels do not give evidence of great activity, we must conclude that the size of the tubules provides no evidence that they produce a gall through their agency.

The larva of Decatoma flava also possesses four tubules. Two are long, clavate, and drawn to a point at their cephalic ends, and two are short with blunt ends, (Fig. 64, Pl. IX). They are more slender, the cells smaller, and the nuclei more regular than those of the Eurytoma larva. The general condition stated regarding the former also applies to Decatoma flava.

It is interesting to note that the galls that contain the highest percentage of parasites and inquilines, and those in which the larva of Dryophanta erinacei have been destroyed at an early stage never reach full development; also that the tissues become dry, hard, and brittle. It is largely from this type of gall that the summer brood of the inquilines, and of Eurytoma studiosa, and Eurytoma auriceps emerge.

The Malpighian Vessels of other Gall-Forming Cynipidæ.

In the agamic form of Holcaspis globulus (Fitch) the Malpighian vessels, as obtained from fresh material, are white in color. They consist of two long tubules with large, globose cells, and irregularly branched nuclei. They give evidence of a high state of activity, and on contact with a foreign substance pour forth a fluid as did Dryophanta erinacei. In the degeneration of the larval tubules and the development of those of the adult they are similar to Dryophanta erinacei, (Figs. 54, Pl. VII and 57, and 58, Pl. VIII).

The agamic form of Dryophanta polita (Bass.), which causes the polished oak gall, possesses two Malpighian vessels which as dissected out are white in color. They are smaller than those of Dryophanta erinacei and Holcaspis globulus. The cells are globose, nuclei irregular, and branched. Their general action is similar to those already discussed. In a longitudinal section they appear as in Figs. 55 and 56, Pl. VII. The process of degeneration of the larval tubules, and the development of the adult vessels correspond to that already described for Dryophanta erinacei. Fig. 55, Pl. VII, is a longitudinal section through a pupa of Dryophanta polita, which shows the degeneration of the larval tubules and the adult vessels forming.

The Malpighian Vessels of Gall-Producing Tenthredinidæ.

The larva of Nematus pomum (Walsh) which causes the willow-apple gall was secured. Longitudinal sections through the larva show cylindrical tubules arising at the union of the mid and hind-gut, and extending caudad, (Fig. 66, Pl. IX). A longitudinal section of the tubule is shown in Fig. 65, Pl. IX. The cells are numerous, small, and regular, the nuclei being symmetrical, and densely packed with chromatin. We have no evidence here of great activity, nor does the larva secrete any fluid when placed on a foreign substance.

Now it is known that the Tenthredinidæ do not produce galls in the same manner as the Cynipidæ, but the stimulus is given at the time of oviposition. Adler says "I have carefully observed Nematus vallisnierii. The fly cuts into the tender leaves of the end shoot of Salix amygdalina, and inserts her eggs in the wound, frequently placing several in one leaf. At the same time some glandular secretion from the insect flows into the wounded leaf. A few hours after this injury, the leaf surface presents an altered appearance, and new cell-formation begins, freely leading to the thickening of the surrounding leaf surface. After the elapse of about fourteen days the green and red, bean-shaped gall is fully grown. If it is now opened the egg will be seen lying in the cavity. Three weeks elapse before the larva emerges from the egg."

Thus it is evident that the Malpighian vessels of the Tenthredinid larva are not factors in gall production.

The Malpighian Vessels of the Gall-Producing Diptera.

The larva of *Trypeta solidaginis*, from the globular gall on the goldenrod, shows Malpighian vessels consisting of small, round cells containing spherical nuclei, (Fig. 68, Pl. IX). The cells show no evidence of exceptional activity, nor have we any reason to believe that the Malpighian tubules are here factors in gall formation.

The larva of *Cecidomyia strobiloides*, which causes the pine-cone willow gall, likewise shows Malpighian vessels of a normal type. The cells are small, very regular, and do not indicate any unusual state of activity, (Fig. 69, Pl. IX).

From a study of these two forms it seems probable that the galls which they form are not due to any product poured forth by the Malpighian vessels, for these neither secrete a fluid when in contact with a foreign substance, nor do the cells show any divergence from the normal type.

The Malpighian Vessels of Other Hymenoptera.

Since we have only considered species which form galls or are associated as parasites and inquilines with the gall-maker, it is necessary that we study related species that do not form galls, in order that this comparative study may be more complete. For this purpose we have selected species of Braconids and Ichneumons.

A Braconid larva was obtained from the fall-webworm. A longitudinal section of this larva is shown in Fig. 67, Pl. IX. The cells of the Malpighian vessels are medium in size, and the nuclei irregular. They are equal to those of the tubules of the Chalcids, and larger than those in the vessels of the inquilines.

The Ichneumon larva was secured from the red-humped apple-worm. Sections through the Malpighian tubules showed that the cells were small and regular, the nuclei round. Here we have a tubule the cells of which correspond in size to those found in the tubules of the inquilines.

The Degeneration of the Larval Malpighian Tubules.

The degeneration of the larval tubules, and the development of the adult vessels in the forms studied, are of such interest that, though in part discussed by Rössig, they may here be considered, and especially since the stages missed by Rössig can be supplied.

Degeneration of the larval Malpighian tubules commences in the prepupal stage. The cytoplasm shows huge vacuoles, appears in shreds, and clings to the cell wall. The nucleus becomes greatly elongate and branched, and chromatolysis sets in. About this time small evaginations appear in the hind-intestine, which develop into cylindrical tubules. Gradually the cells of the larval Malpighian vessels break down, and pass into the lumen of the hind-intestine, while the adult tubules with small cells, and regular nuclei elongate rapidly.

A series of the Malpighian vessels dissected out show this process (Figs. 48, 49, 52, and 53, Pls. VI, and VII).

The method of degeneration and the relation of the phagocytes to this process has been in question. In the process of degeneration as shown in Dryophanta erinacei, Holcaspis globulus, Dryophanta polita, and in the Eurytoma larva, it is clear that the phagocytes play no part whatever. The cells break down and pass into the alimentary tract. Fig. 50, Pl. VII is from a cross section of a larva of Dryophanta erinacei, and shows a fragment of a cell of a tubule found in the lumen of the intestine. Fig. 51, Pl. VII is from a longitudinal section of a similar larva, and shows the degenerating cell just breaking away into the lumen of the intestine. Figs. 54, and 57, Pls. VII, and VIII show the degenerating cells of Holocraspis globulus, also the adult vessels forming. Fig. 55, Pl. VII represents the same condition in Dryophanta polita.

The only instance where phagocytosis was found was in the larva of Trypeta solidaginis. Here as shown in Fig. 76, Pl. X, the phagocytes are present, but from a study of the slide it was evident that chromatolysis had already set in, and the phagocytes were only of secondary importance in the degeneration of the cell.

B. The Relation of the Oenocytes to Gall Formation.

We must now consider the relation of the oenocytes to the production of the gall. Rössig says "The oenocytes have a certain influence, in that they in some manner break up the blood fluid, and work it over in advance for the Malpighian vessels." This conclusion rests on the following: First, a mere comparison of the size of the oenocytes with that of the larva; second, "The general opinion that they are excretory organs destined to store up urates, especially, as Verson has shown in Bombyx, during the time when the Malpighian vessells do not carry out their function, during molting and pupation. Berlese is of the same opinion." Lastly, a possible correlation in the development between the Malpighian vessels and the oenocytes.

Rössig points out that the oenocytes of the various larva which he has studied reach an unusual size. This growth is attained within a short time, after which they shrink and

gradually degenerate. Their size, in comparison with that of the larva, is remarkable. From some of the larva investigated he gives the following:

	LENGTH	OENOCYTES	NUCLEI
Larva of Biohriza terminalis	470μ.	20μ.	
" " Andricus ostreus	375μ.	23μ.	
" " Andricus fecundatrix	450μ.	25μ.	
" " Dryophanta divisa (end of June)	460μ.	20–67μ.	25μ.
" " Dryophanta divisa (17th July)	600μ.	100μ	50μ
" " Dryophanta divisa (end of July)	785μ.	146–150μ.	59μ

From this, the author points out, first the unusual size of the oenocytes as compared with that of the larva, and second the three-fold increase in size of the oenocytes within one month. He also gives measurements of oenocytes found in the inquiline inhabiting the gall formed by Andricus globuli, Vespa crabro, Nematus vallisnierii, Hormomyis fagi, and Aphis mali. With one exception, the larva are all larger than those of the gall wasps, and their oenocytes smaller. Now by a comparison of the size of the oenocytes with that of the larva, and secondly these oenocytes and larva with those of the gall-forming Cynipidæ he endeavors to establish his theory.

In discussing the first point the author says "In no other instance have such large oenocytes been found in so small a larva." Throughout his treatment of the oenocytes this fact is kept continually in the foreground. Mention is made of Kochevnikov's discovery of a remarkable oenocyte 176μ. in a pupa of a honey-bee 15mm.–16mm. in length, but the author points out that, since the oenocytes in Dryophanta divisa are so large as compared with the larva, and the latter so small as compared with the pupa of the honey-bee, (that is, 785μ. as compared with 16mm.), great importance must be attached to the oenocytes of the gall wasps.

Now does the size of the cell in comparison with that of the body determine its importance? It is very doubtful if such evidence can be used to support his conjecture regarding the function of the oenocytes.

In the second place we must discuss the three-fold increase of the oenocytes. This appears to be tabulated from one set of larva in a single species, but is not shown to be constant throughout that species. Now before a general conclusion can be drawn, this triple increase would have to be shown to be constant not only for a large number of larva of Dryophanta

divisa, but also in many species of the gall-forming Cynipidæ. In the following table it will be seen that in Dryophanta erinacei the oenocytes show no remarkable increase in size, and that they reach their maximum long after the Malpighian vessels have passed their period of greatest activity.

TABLE III.

D. ERINACEI.	LENGTH	OENOCYTES	NUCLEI
pupa		56μ.x64μ.	26μ.x32μ.
		64μ.x64μ.	32μ.x32μ.
		48μ.x48μ.	24μ.x24μ.
larva	2½mm.	80μ.x120μ.	32μ.x40μ.
		64μ.x 72μ.	32μ.x32μ.
		48μ.x 64μ.	32μ.x32μ.
"	2¼mm.	64μ.x 56μ.	32μ.x32μ.
		56μ.x 56μ.	24μ.x24μ.
		56μ.x 48μ.	24μ.x24μ.
"	2mm.	72μ.x 76μ.	32μ.x32μ.
		56μ.x 56μ.	24μ.x24μ.
		48μ.x 48μ.	24μ.x24μ.
"	1¾mm.	48μ.x 48μ.	32μ.x32μ.
		40μ.x 40μ.	24μ.x24μ.
"	1½mm.	56μ.x 56μ.	28μ.x28μ.
		48μ.x 48μ.	24μ.x24μ.
"	1¼mm.	48μ.x 52μ.	24μ.x24μ.
		48μ.x 48μ.	24μ.x24μ.
		40μ.x 40μ.	24μ.x24μ.
"	750μ.	40μ.x 48μ.	24μ.x24μ.
		40μ.x 40μ.	24μ.x24μ.
"	500μ.	40μ.x 40μ.	24μ.x24μ.
Eurytoma pupa		88μ.x 88μ.	40μ.x48μ.
		90μ.x 96μ.	48μ.x48μ.
		80μ.x 80μ.	40μ.x40μ.
Eurytoma larva	1¾mm.	88μ.x 80μ.	40μ.x36μ.
		64μ.x 64μ.	40μ.x40μ.
Synergus erinacei larva	1¾mm.	88μ.x 72μ.	32μ.x32μ.
		56μ.x 64μ.	24μ.x24μ.
Internal parasite, larva	750μ.	48μ.x 42μ.	24μ.x24μ.
		40μ.x 40μ.	24μ.x24μ.
Nematus pomum larva		56μ.x 40μ.	24μ.x24μ.
		40μ.x 44μ.	24μ.x24μ.
Trypeta solidaginis larva		72μ.x 80μ.	32μ.x32μ.
		60μ.x 62μ.	32μ.x32μ.

In Table III, the measurements given are constant in a large number of individuals for each species, and from the study of these it will be seen:

1. In Dryophanta erinacei the oenocytes reach their maximum size when the larva measures 2½mm. Fig. 93, Pl. XI shows such an oenocyte.

2. No oenocyte shows a threefold increase during the larval development. The average of the largest oenocytes was 64μ.x40μ., nucleus 32μ. while the smallest was 40μ.x40μ. nucleus 24μ.

3. The oenocytes of the second larval stage are as large as those of the fourth stage.

4. Among the inhabitants of the gall the largest oenocytes, (Figs. 83 and 84, Pl. X). were found in a Chalcid pupa, of the genus Eurytoma, while in a larva 1½mm. long of the same genus the oenocytes were larger than those of a similar sized larva of Dryophanta erinacei. Figs. 85 and 86, Pl. X, show such an oenocyte. It is important to note that these occur in a parasite, which, as pointed out earlier in this paper, does not produce a gall.

5. A 1¾mm. larva of Synergus erinacei possesses oenocytes, (Fig. 87, Pl. X), larger than those of a similar sized larva of Dryophanta erinacei, yet Synergus erinacei is only an inquiline.

6. In an internal parasite of Dryophanta erinacei measuring 750μ. the oenocytes are as large as those of a similar sized host. The parasite does not emerge from Dryophanta erinacei until after the gall has attained full growth, and hence has no part in the production of the gall.

7. The Tenthredinid, Nematus pomum, which develops in a gall not produced by any product poured forth by the Malpighian vessels possesses oenocytes of considerable size, while the Malpighian vessels are normal, (Figs. 80 and 81, Pl. X).

8. The same is true of Trypeta solidaginis, an oenocyte of which is shown in Fig. 82, Pl. X.

Now since the largest oenocytes are not found in Dryophanta erinacei, but in a Chalcid parasite which is not a gall-maker, since there in no triple increase in the oenocytes of Dryophanta erinacei, and further, since there is a distinct limit within the range of which the varying oenocytes of all species really fall, it is clear that the conclusion of Rössig is not substantiated by the present investigation.

"The general opinion that they are excretory organs destined to store up urates, especially, as shown by Verson in Bombyx, during the time when the Malpighian vessels do not carry out their function, during molting and pupation."

In general, students of oenocytes have considered them secreting organs, but as Perez has pointed out in "Contributions à l' Étude de Metamorphosis" we do not know what their secretion is.

It is true that Verson considered the cells secretors of urates in Bombyx, and Koschevnikov discusses the urate-laden

oenocytes of the honey-bee, speaking of them as permanent reservoirs which could not free themselves of their products, and had ceased activity. Berlese also describes oenocytes containing urates in many of the species he has studied. Perez, however, has pointed out that these workers have confounded urate cells with oenocytes, and it is significant to note that Berlese in his recent work "Gli Insetti" does not speak of oenocytes bearing urates, but limits that function to urate cells.

The urate-bearing oenocytes that Rössig describes in Andricus Malpighi have the distinct marks of urate cells, and are probably such. Further, he has shown that the injection of chemically pure urates into the plant tissue gives negative results, and therefore urates are not considered factors in gall production. Suppose that we concede to the oenocytes the function of secreting urates, have we gained anything?

According to the above quotation, the urate-secreting function of the oenocytes is performed particularly during the molting and pupating periods when the Malpighian vessels are not functional. It has been shown that the oenocytes do not secrete urates. In all the species we have studied, urate crystals or urate globules have never appeared in the oenocytes. In Dryophanta erinacei we have never observed any unusual activity in these cells during the periods when the Malpighian vessels are not active, and the same can be stated of Holcaspis globulus, Dryophanta polita, Synergus erinacei, and the Eurytoma larva. Moreoever we do not know the chemical constitution of the secretion seen in the vacuoles of the oenocytes. Therefore we have no reason for assigning to the oenocytes the function of secreting urates.

A Possible Correlation in the Development of the Malpighian Vessels and the Oenocytes.

In discussing this phase of the problem, Rössig states that he cannot speak with certainty, but thinks that at least in Dryophanta divisa a correlation exists between the development of the Malpighian vessels and the oenocytes. He presents the following tabulation:

		MALPIGHIAN VESSELS		OENOCYTES	
	LENGTH	CELLS	NUCLEUS	CELLS	NUCLEUS
D. divisa	460μ.	50μ.	36μ.	50μ.	25μ.
" "	600μ.	73μ.	50μ.	100μ.	50μ.
" "	714μ.	115μ.	56μ.	150μ.	59μ.

From this he concludes that the cells of the Malpighian vessels are doubled in size while those of the oenocytes increase threefold.

Now in comparing Table II and Table III, it will be seen that in Dryophanta erinacei there is no indication of any correlation existing between the oenocytes and the Malpighian vessels. The oenocytes have reached their maximum when the larva is in the prepupal stage, and the Malpighian vessels are largest when the larva measures 1¾mm.—approximately the middle of August. As far as our investigation has gone we have found nothing to support the idea of any correlation in the development of the oenocytes and the Malpighian vessels.

CONCLUSION.

The conclusions drawn from the foregoing study of Dryophanta erinacei are as follows:

1. From a study of the life-history of Dryophanta erinacei we have another illustration of dimorphism in the Cynipidæ.

A. The agamic form of Dryophanta erinacei produces the oak hedgehog gall on the veins of the white oak leaves, passes through five larval stages extending over a period from the last of June to the first of September. Pupation occurs on the first week in September, and the adults emerge about the fifth of November.

B. The adults oviposit on the leaf and flower buds of the same tree.

C. The following spring the eggs hatch, and the larvae produce galls on the leaf scale or the terminal growing points of the buds, from which within two weeks the sexual form of Dryophanta erinacei emerges.

D. These oviposit on the midrib and lateral veins of the young leaves of the white oak. From the eggs deposited emerge the young larvæ which produce the summer gall.

E. The sexual form belongs to the genus Dryophanta, and will therefore be known as the sexual form of Dryophanta erinacei, of which the insect, formerly known as Acraspis erinacei is the agamic form.

2. The study of the parasitic and guest life shows that the following insects inhabit the gall: Decatoma flava (Ashmead); Decatoma querci-lana-dorsalis (Fitch); Decatoma varians

(Walsh); Eurytoma studiosa (Say); Eurytoma auriceps (Walsh) Ormyrus ventricosus (Ashmead); Syntomaspis sp.; Tetrastichus sp.; Synergus erinacei (Bass.)

A. The Chalcids are primarily parasitic on Dryophanta erinacei, and secondarily on each other.

B. The inquiline, Synergus erinacei, is parasitic on the entire life of the gall, mining from cavity to cavity and devouring the larvæ they contain.

C. Eurytoma studiosa and Eurytoma auriceps, and Synergus erinacei have two broods. The spring brood appearing June tenth to fourteenth, and the summer brood appearing from July twenty-fourth to August first.

D. The percentage of parasites, not including the internal parasites, is at least sixty per cent.

3. The Malpighian vessels of Dryophanta erinacei secrete a fluid which stimulates the plant to produce the gall. This is shown by the following:

A. The character of the Malpighian vessels of the sexual and agamic forms of Dryophanta erinacei—their size, cellular structure, and exceptional glandular activity.

B. The character and effect of the secretion poured forth by the Malpighian vessels during gall formation.

C. The ultimate decline and ceasing of marked activity of the tubules when the gall has matured.

D. The increase in the size of the cells of the Malpighian vessels coincident with the development of the gall, and their decrease in size when the demand upon them is withdrawn.

E. A comparison of the Malpighian vessels of Dryophanta erinacei with those of the parasites and the inquilines found in the gall, and particularly the lack of any abnormal secreting activity in the latter.

F. A study of the Malpighian vessels of Holcaspis globulus, and Dryophanta polita, both of which correspond in their action, development, and degeneration to those of Dryophanta erinacei.

G. A comparative study of the Malpighian vessels of Dryophanta erinacei with those of Nematus pomum, Trypeta solidaginis, and Cecidomyia strobiloides shows that all the latter, though gall producers, possess tubules of normal type, which do not pour forth an abundant secretion during gall development, nor when in contact with foreign substances.

H. The study of the Malpighian vessels of species of Braconids and Ichneumons, shows tubules with cells not larger than those of the Chalcids and inquilines. The mode of degeneration however, appears similar to that found in Dryophanta erinacei.

4. The theory of the relation of the oenocytes to gall production as urged by Rössig is not confirmed by this study.

A. His argument is without support from the data furnished by Dryophanta erinacei, Dryophanta polita, and Holocraspis globulus. The oenocytes of the Eurytoma pupa and the larva, Synergus erinacei, are relatively larger than those found in a larva of similar size of Dryophanta erinacei, while the oenocytes of Nematus pomum and Trypeta solidaginis were equal to those found in Dryophanta erinacei.

B. The oenocytes do not secrete urates. Perez has shown this to be true in the ants, and Berlese appears to have now accepted this view. In the oenocytes of the various species studied, we have found no urate crystals or globules.

C. Since we do not know the chemical character of the secretion in the oenocytes, and since there appears to be no unusual activity in these cells during the molting and pupating periods of these species under consideration, we are not convinced that they take the place of the Malpighian tubules during these periods.

Until we know the chemical character of the secretion produced by the oenocytes, we shall only deal in speculation as to the rôle of these cells in insect life.

In conclusion I wish to thank Professor Comstock and Dr. W. A. Riley for the direction, and criticism so freely given, and especially Dr. Riley, at whose suggestion the work was undertaken, and whose assistance was invaluable throughout the entire study.

BIBLIOGRAPHY.

Adler, H. Über den Generationswechsel der Eichen-Gallwespen. Zs. wiss. Zool. Vol. 35, 1880. pp. 151–246.

Anglas, J. Sur l'histologie et l'histogénèse du tube digestif des Hyménoptères pendant la métamorphose. C. R. Soc. Biol. Paris, Vol 50, 1898. pp. 1167–1170.

Note préliminaire sur les métamorphoses internes de la guêpe et de l' abeille. La lyocoytose. C. R. Soc. Biol. Paris, Vol. 52, 1900. pp. 94–97.

Observations sur les métamorphoses internes de la guêpe et de l'abeille. Bull. Sci. France Belgique. Vol. 34, 1901. pp. 363–464; 466–469; 469–473.

Ashmead, W. H. A bibliographical and synonymical catalogue of the North American Cynipidæ. Trans. Amer. Ent. Soc. Vol. 12, 1864. pp. 291–304.

Synopsis of the North American sub-families and genera of the Cynipidæ. Trans. Amer. Ent. Soc. Vol. 13, 1866. pp. 59–64.

Basch, S. Untersuchungen über das chylopoetische und uropoetische system von Blatta orientalis. Sitzungsber. d. nat. naturwiss. Classe d. Akad. d. Wissensch. Wein. Vol. 36, 1858.

Bassett, H. F. On dimorphism in the Cynipidæ. Philadelphia, Pa., Proc. Ent. Soc. Phil. Vol. 3, 1864. pp. 197–198.

Habits of certain gall-insects of the genus Cynips. Can. Ent. Vol. 5, 1873. pp. 91–94.

Agamic reproduction among the Cynipidæ. Proc. Amer. Ass. Adv. Sci. Washington, D. C., Vol. 26, 1877. pp. 302–306.

Arrangement of North American Cynipidæ after Mayr. Amer. Nat. Vol. 16, 1882. p. 329.

and Riley, C. V. List of North American Cynipidæ. Amer. Nat. Vol. 16, 1882. pp. 246–349.

Berlese, A. Osservazioni su fenomeni che avvengeno durante la ninfosi degli insetti metabolici. Rivis. Patol. Veg. Vol. 8, 1899. pp. 1–155.

Considerazioni sulla Fagocitosi negli insetti metabolici. Zool. Anz. Vol. 23, 1900. pp. 441–449.

Vorgänge, welche während der Nymphosis der metabolischen Insekten vorkommen. Zool. Anz. Vol. 24, 1901. pp. 515–521.

Osservazioni su fenomeni che avvengono durante la ninfosi degli insetti metabolici. Rivist. Patol. Veg. Vol. 9, 1902. pp. 177–345.

Berlese, A. Sulle concrezioni cristalline contenute negli organi in dissoluzione e nelle sostanze albuminoi d. in via di digestione nelle ninfe degli insetti metabolici. Anat. Anz. Vol. 21, 1902. pp. 33–48.

Gli insetti. 1909.

Beyerinck, M. W. Beobachtungen über die ersten Entwicklungsphasen einiger Cynipidengallen. Vehr. Ak. Amst. Vol. 22, 1882. pp. iv and 198.

Bordas, M. L. Les tubes de Malpighi des Hyménoptères. Bull. Sci. France Belgique. Vol. 26, 1895. pp. 402–441.

Les tubes de Malpighi des Orthoptères. C. R. Ac. Paris. Vol. 124, 1897. pp. 46–48.

Insertion des tubes de Malpighi chez les Gryllidæ. Bull. Soc. ent. France. 1901. pp. 227–228.

Structure du réceptacle urinaire et du canal excréteur (urêtre) des tubes de Malpighi chez les Gryllidæ. C. R. Soc. Biol. Paris. Vol. 54, 1902. pp. 639–640.

Structure des tubes de Malpighi, du réceptacle urinaire et du canal excréteur (urêtre) des Gryllidæ. Bull. Soc. ent. France. Vol. 16, 1902. pp. 272–273.

Beutenmuller, W. The species of Biorhiza, Philonix and allied genera, and their galls. Bull. Amer. Mus. Nat. Hist. Vol. 26, 1909. pp. 243–256.

Chatin, J. Note sur la structure de no yau dans les cellules marginales des tubes de Malpighi chez les insectes et les Myriopodes. Ann. Sci. Nat. (Zool.), Paris. Vol. 14, 1882. p. 7.

Cholodkowski, N. Sur les vaisseaux de Malpighi chez les Lépidoptères. C. R. Acad. sci. Paris. Vol. 98, 1884. pp. 631–633.

Contributions à l'anatomie et la morphologie des vaisseaux malpighiens des Lépidoptères. C. R. Acad. sci. Paris. Vol. 99, 1884. pp. 816–819.

Sur la morphologie de l'appariel urinaire des Lépidoptères. Arch. Biol. Vol. 6, 1887. pp. 497–514.

Cook, M. T. Galls and insects producing them. Ohio Nat. Vol. iii, 1903. pp. 419–436.

Davy, L. Additional notice on the urinary excrements of insects with some observations on that of spiders. Edinburg New Physiol. Jour. Vol. 40, 1846. pp. 231–234.

Some observations on the excrements of insects. Trans. Ent. Vol. 2, iii, 1854. p. 18.

On the urinary secretion. Trans. Botal. Soc. Edin. Vol. 21, 1857. p. 251.

Giard, A. Note sur l'organe appelé spatula sternalis, et sur les tubes de Malpighi des larves de Cécidomyes. Bull. Soc. ent. France. Vol. 62, 1893. p. 80.

Sur le déterminisme de la métamorphose. C. R. Soc. Biol. Paris. Vol. 52, 1900. pp. 131–134.

Griffiths, A. B. Investigation on the Malpighian tubes etc. Edinburg, Proc. R. Soc.

On the Malpighian tubules of Libellula depressa. Edinburg, Proc. R. Soc. Vol. 15, 1889. pp. 401–403.

Horvath, G. Die excrement der gallenbewohnenden Aphiden. Wein. ent. Z. Vol. 6, 1887. pp. 249–254.

Karawaiew, W. Die nachembryonale Entwicklung von Laisus flavus. Zs. wiss. Zool. Vol. 64, 1898. pp. 385–478.

Kunckel d'Herculais, J. Sur les fonctions des tubes de Malpighi. Bull. Soc. ent. France. Vol. 1896. pp. 209–210.

Koschevnikov, G. A. Über den Fettkörper und die Oenocyten der Honigbiene (Apis mellifica). Zool. Ans. Vol. 23, 1900. pp. 337–353.

Kowalewsky, A. Ein Beitrag zur Kenntnis der Exkretionsorgane Insekten. Biol. Centralbl. Vol. 9, 1889. pp. 42–47; 65–66.

Sur les organes excréteurs ches les Arthropodes terrestres. Congr. Zool. Vol. 1, 1892. pp. 187–235.

Leger, L. et Duboscq, O. Sur les tubes de Malpighi des Grillons. C. R. Soc. Biol. Paris (11) Vol. 1, 1899. p. 527.

Leger, L. et Hagenmuller, P. Sur la structure des tubes de Malpighi chez quelques Coléoptères ténébrionides. Bull. Soc. ent. France. Vol. 68, 1899. p. 192.

MacMunn, C. A. Note on a method of obtaining uric acid crystals from the Malpighian tubes of insects. J. Physio., Cambridge. Vol. 7, 1886. p. 128.

Marchal, P. L'Acide urique et la fonction rénale chez les Invertébrés. Mém. Soc. Zool. Fr. Vol. 3, 1890. pp. 61–77.

Remarques sur la fonction et l'origine des tubes de Malpighi. Bull. Soc. ent. France, Vol. 1896. pp. 257–258.

Mann, P. Contributions to the knowledge of parasitic life in galls. Psyche. Vol. 4, 1883. pp. 89–91.

Mayet, V. Une novelle fonction des tubes de Malpighi. Bull. Soc. ent. France. Vol. 1896. pp. 122–127.

Mayr, G. Die Genera der gallenbewohnenden Cynipiden. Wein. Vol. 8, 1881. p. 44.

Milne-Edward, H. Observations sur la sécrétion urinaire chez les insects. Ann. Soc. ent. France, 1833, p. 64.

Moller, G. Fr. Bidrag till Kännendomen om Parasitlifvet i Galläpplen och dylika Bildningar. Entomol. Tidskr., Stockholm, Vol. 3, 1882. pp. 182–186.

Osten-Sacken, C. R. Von. Über den wahrscheinlichen Dimorphismus der Cynipiden-Weibchen. Stettiner ent. Ztg. Vol. 25, 1864. pp.409–413.

Packard, A. S. A text book of entomology. New York. 1898.
Perez, C. Sur la métamorphose des insects. Bull. Soc. ent. France, 1899.
Histolyse des tubes de Malpighi et des glandes sericigènes chez la fourmi rousse. Bull. Soc. ent. France, 1901. pp. 307–310.
Sur. les oenocytes de la fourmi rousse. Bull. Soc. ent. France, 1901. pp. 351–353.
Contributions à l'étude des métamorphose. Thesis. 1902.
Reinhard, D. Die Hypothesen über die Fortpflanzungsweise bei den eingeschlechtigen Gallwespen. Berlinger ent. Zs. Vol. 9, 1865. pp. 1–13.
Rossig, H. Von welchen Organen der Gallwespenlarven geht der Reiz zur Bildung der Pflanzengalle aus? Zool. Jahrb., Jena. Vol. 20, 1904. pp. 19–90.
Schaffer, C. Beiträge zur Histologie der Insecten. Zool. Jahrb. Vol. 3, 1889. Anat. Abth. pp. 611–652.
Schlechtendal, D. H. R. Beobachtung über Gallwespen. Stettin. Entom. Z. 1870. pp. 338–347; 376–398.
Schindlre, E. Beiträge zur Kenntnis der Malpighischen Gefässen der Insekten. Zeitsch. f. wiss. Zool. Vol. 30, 1878. pp. 587, 660.
Seurat, L. G. Sur le developpement post-embryonnaire des Braconides. Bull. Mus. Nat. Hist. Paris. Vol. 4, 1898. pp. 267–270.
Sinety, R. De. Les tubes de Malpighi chez les Phasmes. Bull. Soc. ent. France. Vol. 17, 1900. pp. 333–335.
Sirodot, M. S. Recherches sur les sécrétion urinaire chez les Insectes. Ann. Scien. Nat. N. S. Vol. 10, 1858. p 257.
Vaney, C. Note sur les tubes de Malpighi des larves de Stratiomys. Bull. Soc. ent. France, 1900. pp. 360–361.
Veneziani, A. Interno al numero dei tubi di Malpighi negli Insetti. Acc. Scienza Medics. Ferrara, 1903.
Valore morforlogico, fisiologico e filogenetico dei Tubi Malpighiani. Contributo alla conoscenza del meccanismo fisiologico nell'escrezione. Ferrara, 1903. p. 90.
Valore morfologico, fisiologico e filogenetico dei Tubi Malpighiani. Ferrara, 1904.
Valore morfologico e fisiologico dei Tubi malpighiani. (contributo alla conoscenza del meccanismo dell' escrezione). Redia, Vol. 11, 1905. pp 177–230.
Verson, E. Altre cellule glandulari di orgine post larvale. Bull. Ent. Ital. Vol. 24, 1892. pp. 3–17.
Beitrag zur Oenocyten-Literatur. Zool. Anz. Vol. 5, 1900. pp. 657–662.
Observations on the structure of the exuvial glands and the formation of the exuvial fluid in insects. Zool. Anz. Vol. 25, 1902. pp. 652–654.
Verson, E. and **Bisson E.** Cellule glandulari ipostigmatiche nel Bombyx mori. Firenze, Boll. Soc. Entom. Ital. Vol. 23, 1891. pp. 3–19.
Les cellules glandulaires hypostigmatiques dans le Bombyx mori. Archiv. Ital. de Biol. Vol. 15, 1891.
Walsh, B. D. On dimorphism in the Hymenopterous genus Cynips. Philadelphia, Pa., Proc. Ent. Soc. Phil. Vol. 11, 1864. pp. 409–413.
Walsh, B. D. and **Riley, C. V.** Alterations of generations. Amer. Ent. Vol. 1.
Weissenberg, R. Über die Oenocytes von Torymus nigricornis, Boh. Zool. Jahrb., Jena. Vol.23, 1906. pp. 231–268.
Wheeler, W. M. The primitive number of Malpighian vessels in insects. Psyche. Vol. 6, 1893. pp. 457–460.
Witlaczil, E. Zur Anatomie der Aphiden. Zool. Anz. Leipzig. Vol. 5, 1882. pp. 239–241.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. Oak Hedgehog Gall attached to the midrib of a White Oak leaf.
Fig. 2. Longitudinal section through a Gall. A. Central cavities; B. Lateral Cavities.
Fig. 3. Agamic form of D. erinacei ovipositing on the bud of White Oak.
Fig. 4. Female, sexual form of D. erinacei.
Fig. 5. Pupa of agamic form of D. erinacei.

PLATE II.

Fig. 6. Bud scale with eggs of agamic form attached.
Fig. 7. Bud scale with enlarged gall, egg-shell still attached.
Fig. 8. Longitudinal section through Oak Hedgehog Gall showing Peripheral Cavity.
Fig. 9. Bud scale on which young gall is forming with empty egg-shell attached.
Fig. 10. Terminal Galls.
Fig. 11. Oblique section through Oak Hedgehog Gall showing where S. erinacei has mined from A – B.
Fig. 12. Longitudinal section through Oak Hedgehog Gall showing where S. erinacei has mined from A – B, and is breaking down the wall at C.

PLATE III.

Fig. 13. Mandible of Agamic form of D. erinacei.
Fig. 14. Maxilla of Agamic form of D. erinacei. A. Cardo; B. Stipes; C. Palpus; D. Galea.
Fig. 15. Labium of Agamic form of D. erinacei. A. Palpus; B. Glossa; C. Paraglossa.
Fig. 16. Antenna of Agamic form of D. erinacei.
Fig. 17. Two distal segments of antenna showing sensory pits.
Fig. 18. Aborted wings of agamic form of D. erinacei.
Fig. 19. Larva of agamic form of D. erinacei.
Fig. 20. Egg of agamic form of D. erinacei.
Fig. 21. Mandible of sexual form of D. erinacei.
Fig. 22. Maxilla of sexual form of D. erinacei. A. Cardo; B. Stipes; C. Palpus; D. Galea.
Fig. 23. Labium of sexual form of D. erinacei. A. Palpus; B. Glossa; C. Paraglossa.
Fig. 24. Wings of sexual form of D. erinacei.
Fig. 25. Egg of sexual form of D. erinacei.
Fig. 26. Scutellum of sexual form of D. erinacei.
Fig. 27. Larva of sexual form of D. erinacei.
Fig. 28. Antenna of sexual form of D. erinacei.
Fig. 29. Distal segments of antenna showing sensory pits.

PLATE IV.

Fig. 30. Larva of internal parasite from agamic form of D. erinacei.
Fig. 31. Egg of Ormyrus ventricosus.
Fig. 32. Egg of Decatoma flava containing embryo.
Fig. 33. Mandible of Eurytoma larva.
Fig. 34. Larva of Decatoma flava.
Fig. 35. Larva of Eurytoma sp.
Fig. 36. Diagram showing location of setæ on segments of larva of S. erinacei (spring brood).
Fig. 37. Eurytoma egg with larva emerging.
Fig. 38. Larva of S. erinacei (summer brood).
Fig. 39. Egg of S. erinacei (summer brood).
Fig. 40. Larva of S. erinacei (spring brood).
Fig. 41. Egg of S. erinacei (spring brood).

PLATE V.

Fig. 42. Diagram showing location of setæ on segments of larva of Decatoma flava.
Fig. 43. Diagram showing location of setæ on segments of Eurytoma larva.
Fig. 44. Diagram showing location of setæ on segments of larva of S. erinacei (summer brood).

PLATE VI.

Fig. 45. Longitudinal section through larva of agamic form D. erinacei showing Larval Malpighian tubule, Valve, mid-intestine hind-intestine.
Fig. 46. Longitudinal section through larva of agamic from of D. erinacei showing larval Malpighian vessel, mid-intestine, hind-intestine, and hypodermis.
Fig. 47. Longitudinal section showing larval Malpighian vessel extending the length of the mid-intestine.
Fig. 48. Larval Malpighian tubules as dissected out from D. erinacei, agamic form.
Fig. 49. Degenerating larval Malpighian tubules, and adult vessels forming, as dissected out from D. erinacei, agamic form.

PLATE VII.

Fig. 50. Cross section from D. erinacei, agamic form, showing cell of larval Malpighian tubule in the lumen of the intestine, and adult vessel forming.
Fig. 51. Longitudinal section from larva of D. erinacei, agamic form, showing cell just breaking away into the lumen of the intestine.
Fig. 52. Larval Malpighian tubules of D. erinacei greatly reduced, and adult vessels nearing maturity.
Fig. 53. Larval Malpighian tubules of D. erinacei reduced to a few cells, adult vessels well developed.
Fig. 54. Longitudinal section of degenerating larval Malpighian vessel, with adult tubules forming from H. globulus, agamic form.
Fig. 55. A portion from a longitudinal section of a larva of D. polita, agamic form. showing degenerating larval tubules, and adult vessels forming.
Fig. 56. Longitudinal section through cells of degenerating larval Malpighian vessels of H. globulus.

PLATE VIII.

Fig. 57. Larval and adult Malpighian vessels of H. globulus as dissected out.
Fig. 58. Portion of longitudinal section of larval Malpighian vessel of H. globulus.
Fig. 59. Longitudinal section through degenerating cells of Malpighian vessel of H. globulus.
Fig. 60. Larval Malpighian vessels of S. ernacei as dissected out.
Fig. 61. Longitudinal section through cells of larval Malpighian vessel of S. erinacei.
Fig. 62. Larval Malpighian vessels of Eurytoma larva as dissected out.
Fig. 63. Longitudinal section through cells of Malpighian vessel of a Eurytoma larva.

PLATE IX.

Fig. 64. Larval Malpighian vessel of D. flava as dissected out.
Fig. 65. Longitudinal section through cells of Malpighian vessel from Nematus pomum.
Fig. 66. Longitudinal section showing attachment of larval Malpighian tubules to alimentary tract of N. pomum.
Fig. 67. Section showing larval Malpighian vessels, and adult tubule just appearing.
Fig. 68. Longitudinal section through a portion of a larval Malpighian tubule of T. solidaginis.
Fig. 69. Longitudinal section through a portion of a larval Malpighian tubule of C. strobiloides.

Fig. 70. Longitudinal section through a portion of a larval Malpighian tubule of D. erinacei, sexual form.
Fig. 71. Longitudinal section through a portion of a larval Malpighian vessel of an Ichneumon.
Fig. 72. A cross section of a larval Malpighian tubule of D. erinacei, agamic form.

PLATE X.

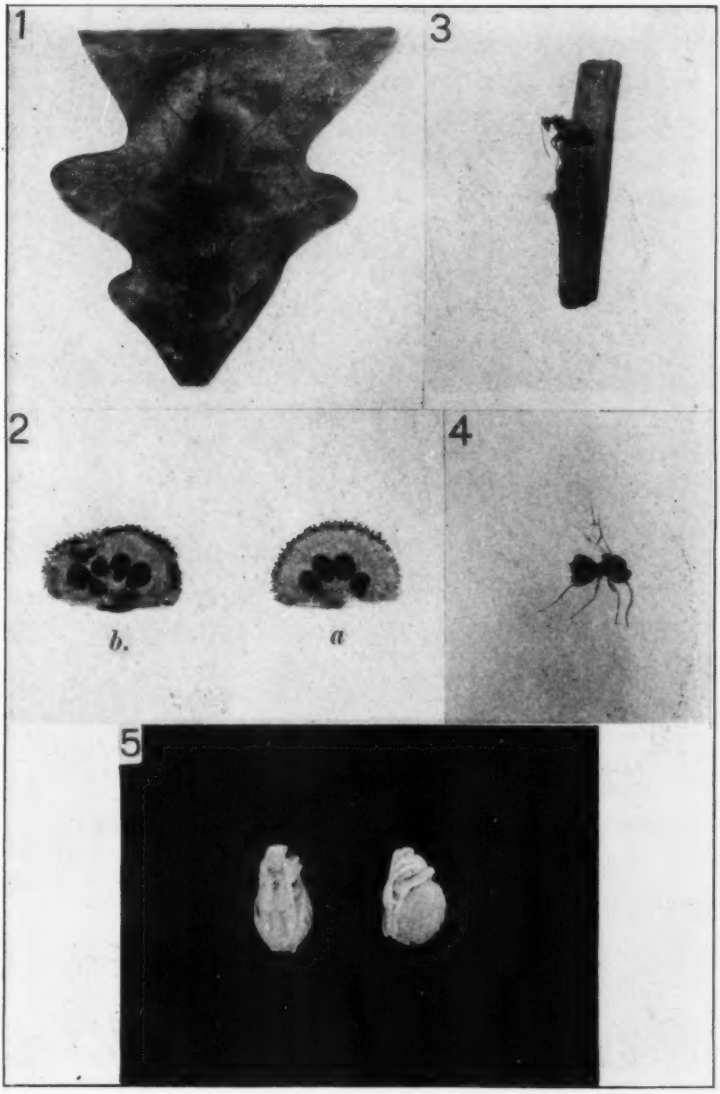
Fig. 73. A cross section of a larval Malpighian vessel of the same species showing degenerating cells.
Fig. 74. Cross section of an adult Malpighian tubule of D. erinacei.
Fig. 75. Cross section of larval Malpighian tubule of N. pomum.
Fig. 76. Cross section of larval Malpighian tubule of T. solidaginis showing phagocytes.
Fig. 77. Cross section of a larval Malpighian vessel of C. strobiloides.
Fig. 78 and 79. Oenocytes from larva of N. pomum.
Fig. 80 and 81. Oenocytes from larva of internal parasite in D. erinacei.
Fig. 82. Oenocyte from larva of T. solidaginis showing vacuoles.
Fig. 83. Oenocyte from thorax of Eurytoma pupa.
Fig. 84. Oenocyte from the abdomen of a Eurytoma pupa.
Fig. 85. Oenocyte from the thorax of a Eurytoma larva 1¾mm.
Fig. 86. Oenocyte from the abdomen of a Eurytoma larva 1¾mm.
Fig. 87. Oenocyte from S. erinacei containing vacuoles.

PLATE XI.

Fig. 88. Oenocytes from the abdomen of a larva of D. erinacei 1½mm.
Fig. 89. Oenocytes from the abdomen of a larval of D. erinacei 2¼mm.
Fig. 90. Oenocytes from the abdomen of a larva of S. erinacei.
Fig. 91. Oenocytes from the thorax of a larva of H. globulus.
Fig. 92. Oenocytes from the abdomen of a larva of H. globulus.
Fig. 93. Oenocyte from the thorax of a larva of D. erinacei 2½ mm.
Fig. 94. Oenocyte from the abdomen of a larva of D. erinacei 2½mm.
Fig. 95 and 96. Oenocyte from a larva of D. erinacei 2mm.
Fig. 97. Oenocyte from a larva of D. erinacei 1¼mm.
Fig. 98. Oenocyte from a larva of D. erinacei 1mm.

ABBREVIATIONS.

c. l. m. t. ..... Cell of larval Malpighian tubule
e. ..... Egg
h. int. ..... hind-intestine
hyp. ..... hypodermis
i. m. t. ..... Imaginal Malpighian tubule
md. ..... Mandibles
mx. ..... maxilla
m. d. ..... mid-dorsal
m. v. ..... mid-ventral
m. int. ..... mid-intestine
la. ..... labium
l. ..... lateral
l. ..... lumen
l. m. t. ..... Larval Malpighian tubules
oe. ..... oenocytes
ph. ..... phagocytes
s. g. ..... scale galls
s. p. ..... sensory pits
s. ..... setæ
t. g. ..... terminal galls
vac. ..... vacuoles



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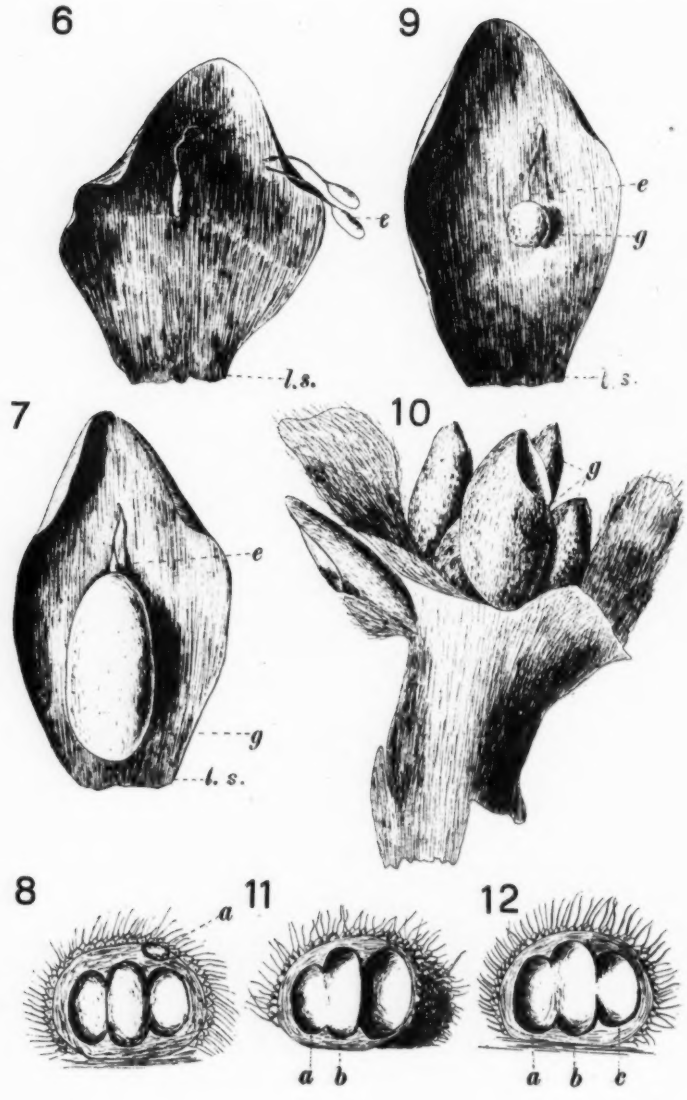

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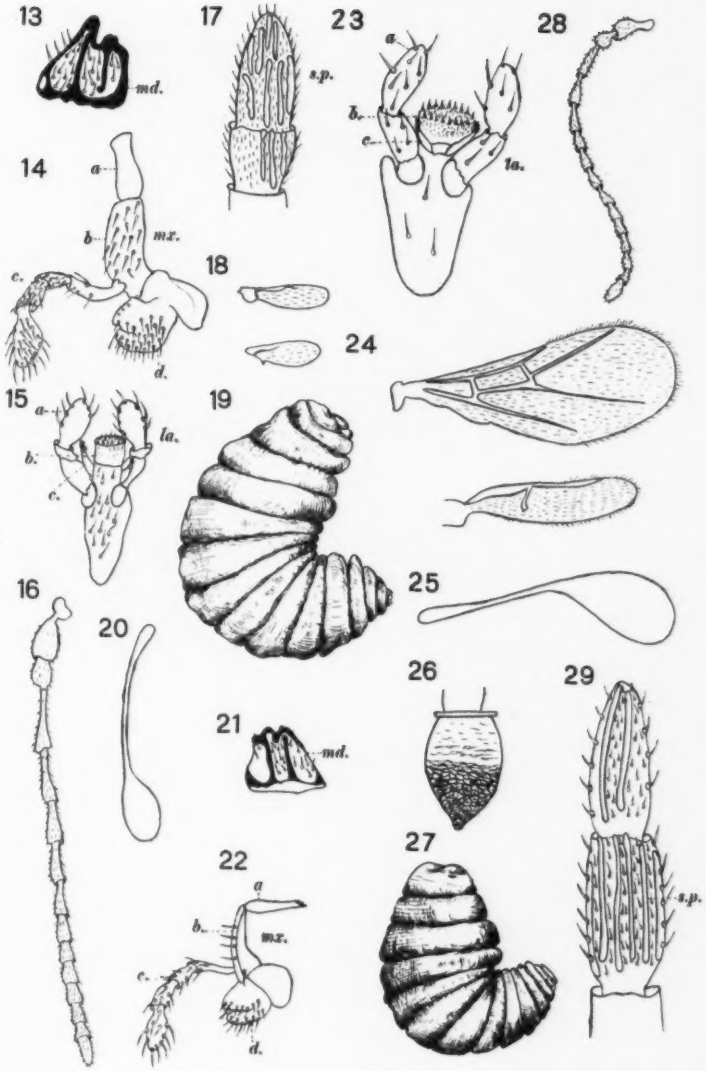

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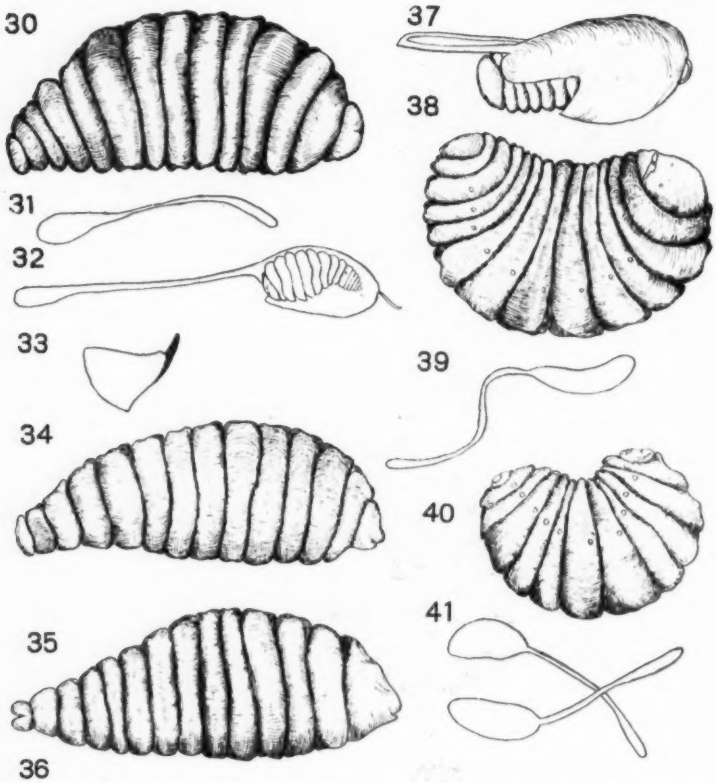

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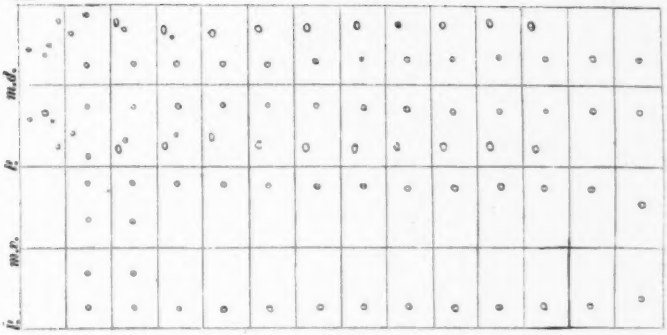
42



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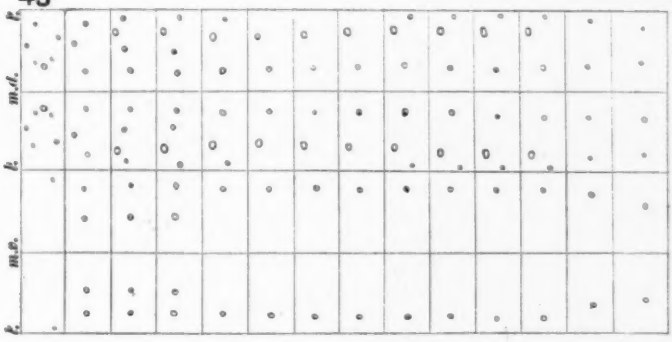

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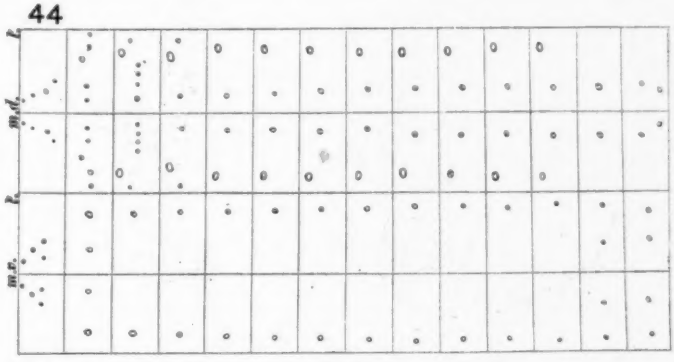

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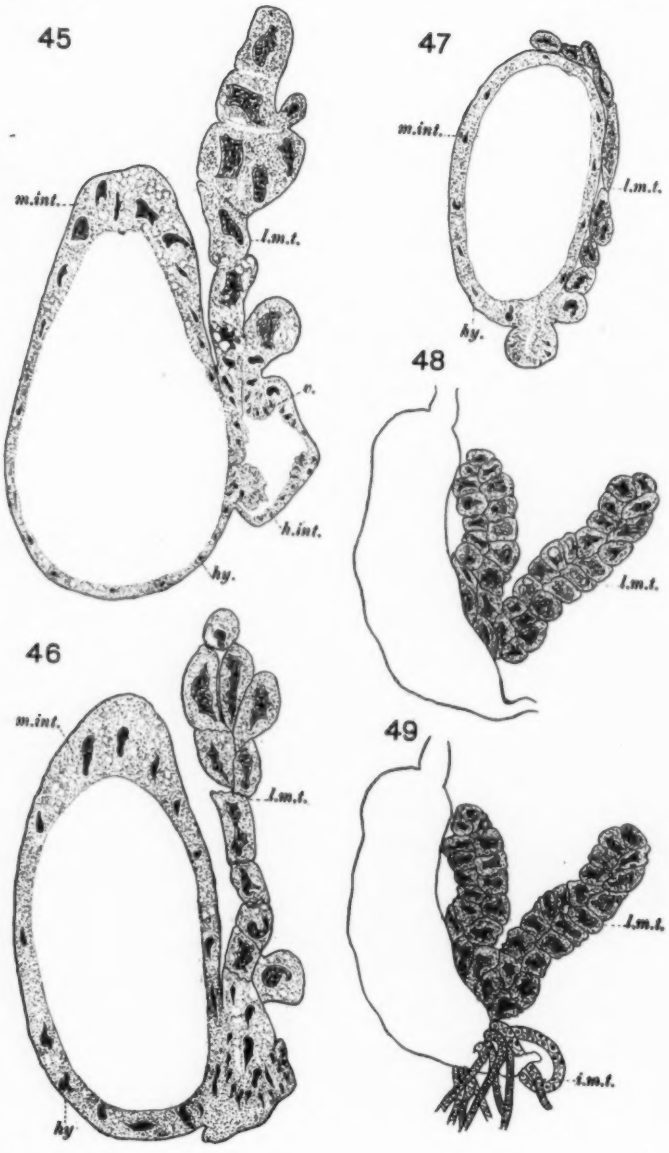

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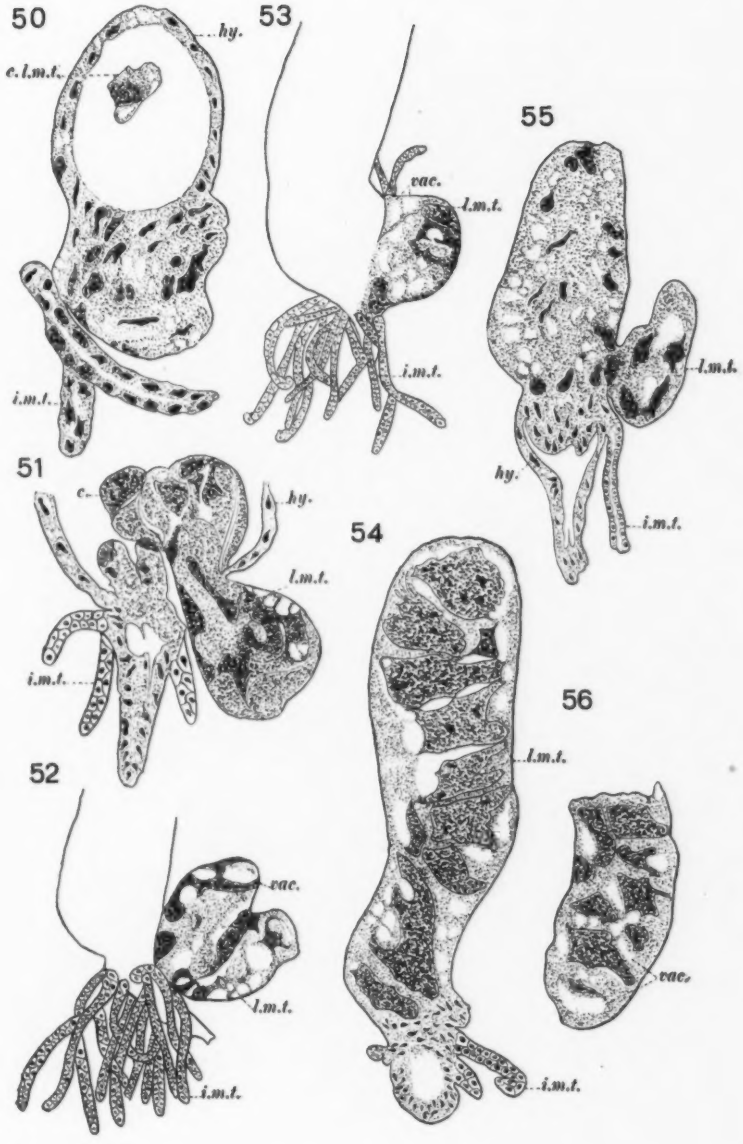

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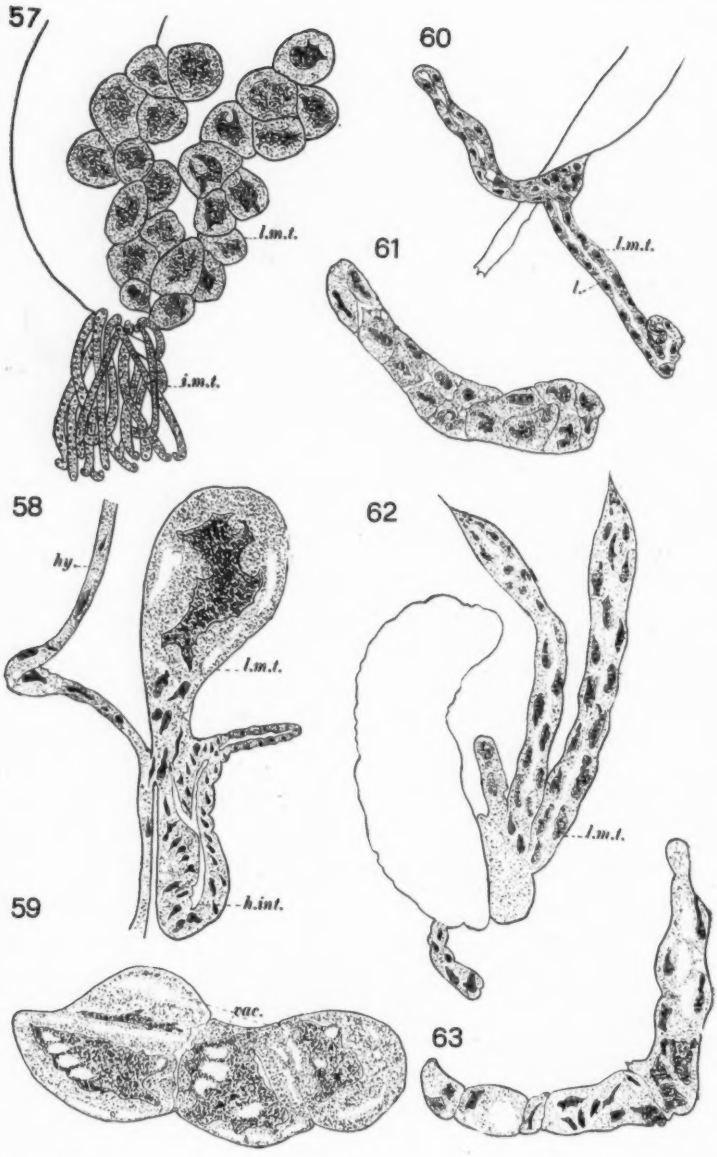

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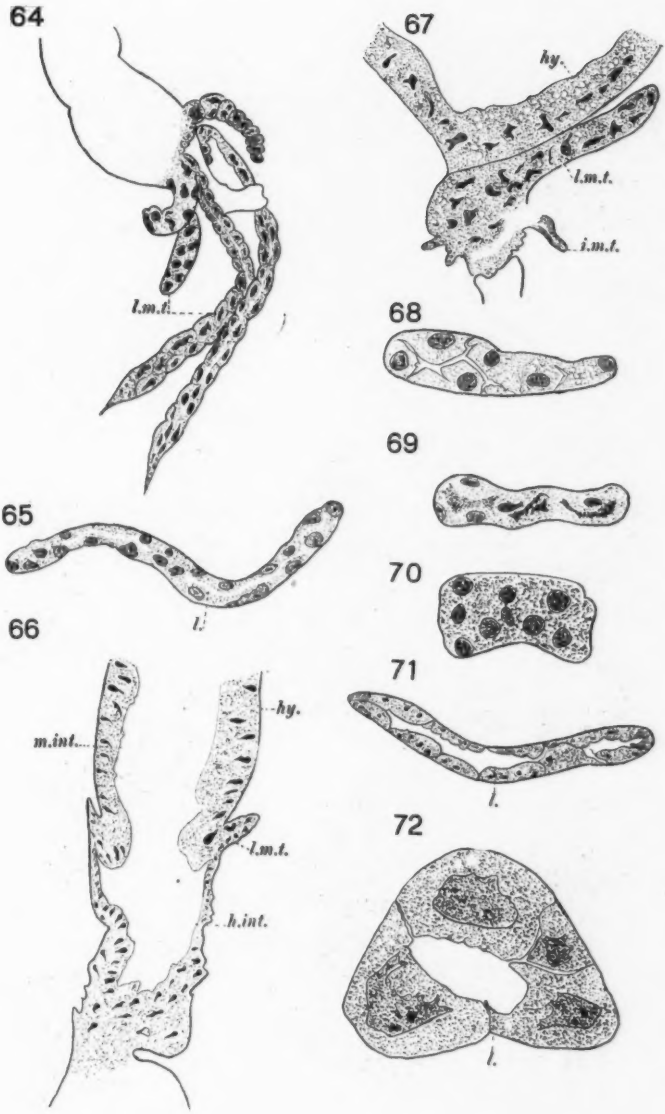

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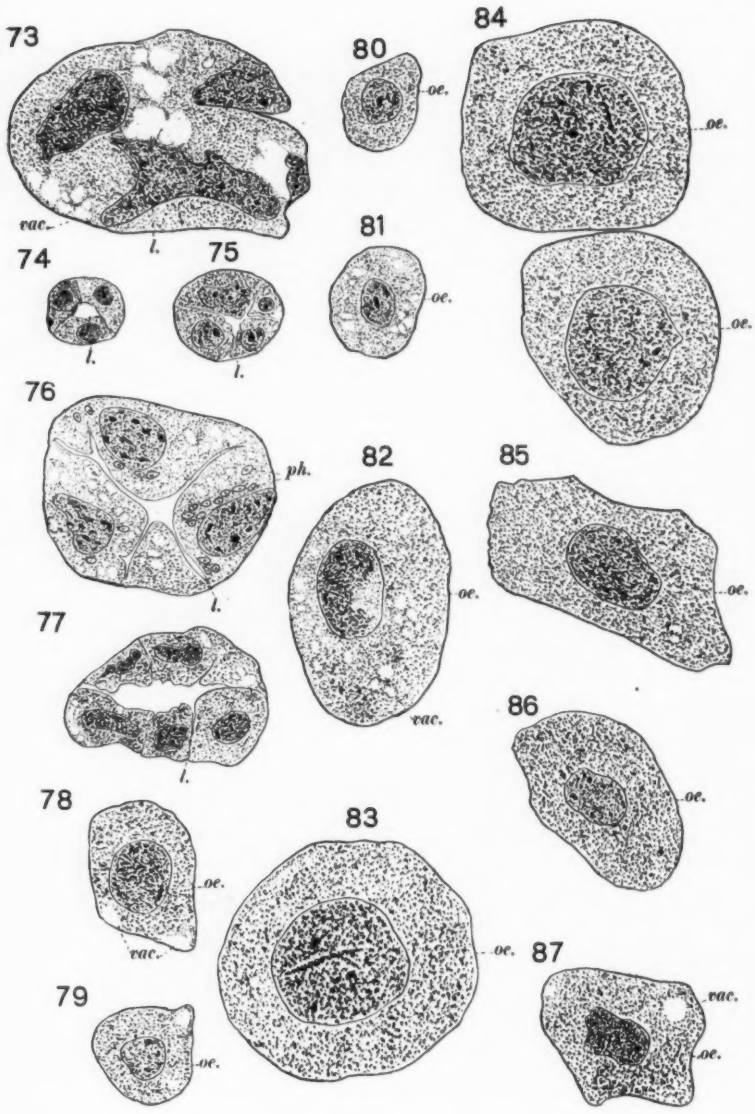

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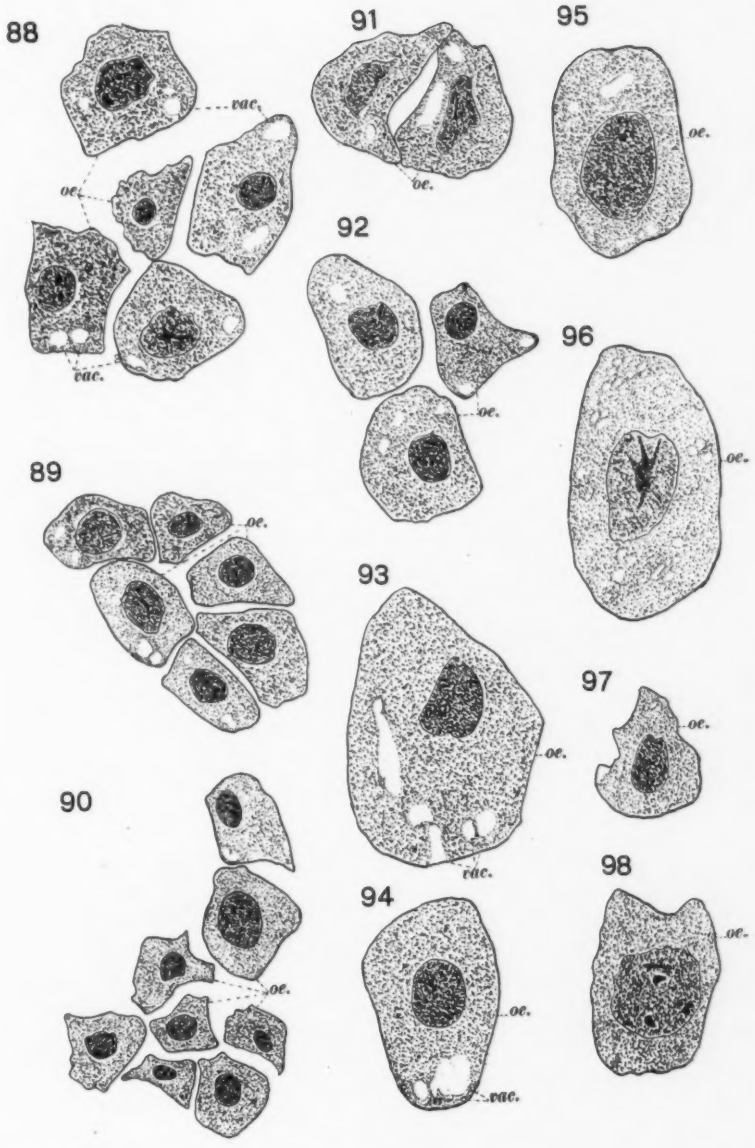


C. J. Triggerson.

THE ANATOMY OF THE DIASPININE SCALE INSECT EPIDIASPIS PIRICOLA (DEL GUER.).

By LEROY CHILDS, Stanford University, California.

The anatomy of several species of scale insects (Coccidæ) has been studied in the entomological laboratories of Stanford University, these species representing several different genera, such as Physokermes, Ceroputo and Icerya. All these, however, are of more or less generalized type and show but little marked divergence from a common form. Comparatively little work has been done in this laboratory or elsewhere on the anatomy of the more specialized Coccidæ, the Diaspinæ.

It is the purpose of this paper to describe the more important anatomical characteristics that are representative of the sub-family Diaspinæ as a whole. A knowledge of the facts of the make-up and functions of the parts should add to the interest of any study of the sub-family, whether the student have the viewpoint of an economic or systematic entomologist. In taking a particular member of the sub-family for this study, I have chosen the species familiarly known as the Italian pear scale *Epidiaspis piricola* (Del Guer). It is one commonly found about the University and in the whole Santa Clara Valley.

In studying the anatomy of such a small and well chitinized insect a number of difficulties of technic present themselves. The first thing that must be considered is the method of killing. Embedding and cutting were also features that demanded considerable experimentation before desirable results were obtained.

Three killing fluids were experimented with in particular; Towers' formula No. 2, Gilson's, and hot water. The latter proved to be the most useful. A fourth, Carnoy's mixture of six parts of absolute alcohol, three parts of chloroform and one part of glacial acetic acid, was also used somewhat for killing. It brought out the nervous system admirably, but the other tissues were badly distorted or destroyed by the action of this powerful agent.

The orienting of the material in the paraffine, ready for sectioning, was a little problem in itself, on account of the minuteness of the insect. The best results were obtained by

the following means: A small paper receptacle was half filled with melted 55% paraffine and allowed to cool considerably. The insect was then taken up in melted paraffine in a warm pipette, and dropped into the receptacle, which was then filled. The specimen was then moved into desired position with a warmed needle. After following this method of embedding, little trouble was experienced in trimming up the block, and the cutting could be done with accuracy in the plane wished.

Necessary care must, of course, be taken in seeing that all material is thoroughly embedded or the sections are very liable to tear when the knife comes in contact with the tough, chitinous covering of the insect. This chitin was found to be extremely impenetrable, and all attempts at staining *in toto* proved futile, though specimens were allowed to stay in the staining fluid for days.

This paper was prepared in the Entomological Laboratory of Stanford University, under the direction of Professor V. L. Kellogg. I am indebted also to Professor Harold Heath for suggestions during the work.

NERVOUS SYSTEM.

The nervous system (Plate XII, Fig. 4) of the Coccidæ seems to vary little in structural characteristics in the many widely differing groups of the family. The central system consists of a fused, bi-lobed cephalic ganglion forming the brain, and a prominent compressed thoracic ganglion from which four pairs of lateral nerves are given off. The posterior pair curve out towards the lateral margins of the insect and then curve back again apparently fusing or at least giving off a great number of smaller nerves which form a delicate fan-shaped nerve center in the pygidium. The circum-oesophageal connectives, (Plate XII, Fig. 4-a) are exceptionally long in Epidiaspis and, together with this lesser nerve center just mentioned, represent the chief differences of the Diaspinæ from the other forms studied. This pushing forward of the brain and the lengthening of the oesophageal commissures is undoubtedly a result of specialization arising from the development of the mouth-parts. The extremely well developed muscles that govern the sucking apparatus are found just below the brain, and it is undoubtedly their growth that has pushed forward

the more or less functional brain. However, a nerve can be seen arising from either side of the lobes reaching out towards the antennal rudiments.

Experiments were undertaken to ascertain the insect's sensitiveness to touch, which show that there is a decided lack of visible response to any sort of stimulus. The only movement that could be noted was that of the drawing in, or telescoping, of the posterior region when touched with a needle. This shortening takes place through the contraction of the segments. No other movement of the body was observed in response to other stimulants such as light, heat and water.

DIGESTIVE SYSTEM.

The Diaspinæ present an extraordinary arrangement of the digestive system, diverging in this respect considerably from the other sub-fâmilies. Dr. A. Berlese, the well known Italian biologist, seems to be about the only man who has done any considerable amount of work on this group, and he reports a very novel condition of the system. He describes elaborately in his studies, the arrangement of the organs of digestion and assimilation, and finds that the stomach is entirely disconnected from the intestine and the rectum. This condition seems to be almost unbelievable. It is a condition met with usually only in certain animal forms where there occurs a regurgitation of undigestible foods. Such an action is highly improbable among the Diaspinæ. Certainly no one has ever observed this phenomenon among them and the removal of wastes can probably be explained in another way.

The digestive epithelium of the stomach of Epidiaspis is made up of very large cells (Plate XIII, Fig. 9-a) with correspondingly large nuclei. The action of the digestive secretions on the ingested plant juices is such that it reduces them to a condition where they can be taken up by the blood-plasma and used for food, reaching this medium by osmosis through the walls of the blind sac or stomach. With the food also passes that which is of no use to the insect and which is taken care of by the exceedingly well developed Malpighian tubules, of which there is a single very large pair, (Plate XIII, Fig. 9-b). These excretory organs are fused, and at the very point of fusion a short duct leads into the rectum to which the

Malpighian tubes are attached by a filament (Plate XIII, Fig. 9-e) a short distance above the anal aperture. The proportionately large size of these tubules indicates that their function is not of ordinary or small proportions. They are made up of exceedingly large granular cells, with distinct nuclei, surrounding a thread-like lumen leading forward to the fusion of the two tubules, from which there is a connection into the tube leading into the rectum. These organs must be considered primarily as organs of excretion and capable of taking from the body cavity not only that material taken in with the food, but removing from the system the waste products of metabolism.

Dr. Berlese declares that there is absolutely no continuous connection from mouth to intestine. However, the writer finds some sections in his series that show what can hardly be denied to be direct connections, (Plate XIII, Fig. 9-c). Berlese's theory of digestion and assimilation is quite plausible and there is a good argument for its probability, for this connection, at best, is very small. The greater number of the sections that have been made—and I have sectioned several score of specimens—show the condition as Dr. Berlese describes. But it seemed possible that the result might be due to an imperfect technic, so that to find a united alimentary canal was the cause for cutting so much material. The results seem to point to this accomplishment. I think that it is in the killing that the trouble lies. We have to do with an insect with a rigid, chitinous exterior with the anal aperture and esophagus attached to chitin. The intermediate system possesses two large bodies, the stomach and the Malpighian tubules, joined by a very delicate intestine, which, unable to withstand the sudden shock of certain killing fluids, is ruptured, with the natural result that many, if not most, of the insects, show a disconnected digestive system.

This condition might possibly vary in the different Diaspinine genera, yet this is not probable. More work is still to be done on the group as a whole, and should this finding be true it will be a point of morphological importance at least, though perhaps not altering the present accepted theory in regard to the manner in which this system carries on its digestive and secretive functions.

REPRODUCTIVE SYSTEM.

The female reproductive system of Epidiaspis (Plate XIV, Figs. 14 and 15), is found to be characteristic of the usual insect type, consisting of a pair of ovaries joined to the vagina to form a figure much the shape of a capital Y. The vagina is a rather long, thick duct, lined with prominent gland cells with prominent nuclei, which undoubtedly secrete a tough, shell-like material during the passing of the eggs. The vagina opens on the ventral surface opposite the anal aperture. At the junction of the two branches of the vagina is found the minute opening of the seminal receptacle (Plate XIV, Fig. 14-b). This sperm sac is a long blind tube (Plate XIV, Fig. 16), and at the time observations were made was filled with an exceedingly large quantity of sperm cells, which could often be seen in the semi-cleared specimens under the microscope.

From the branches of the ovaries, masses of ovariole buds are given off, varying in size from a mere evagination of the egg tube to that in which the eggs are well developed (Plate XIV, Fig. 14-a). Each of these ovarioles is capable of producing a single egg, which, upon reaching maturity, passes down the slender connective into the vagina (Plate XIV, Fig. 15-c), and thence to the exterior. It is quite evident that all of these buds do not develop, and I have noted that the female apparently stops feeding to any great extent after egg laying begins. Consequently after a certain number of eggs have been deposited, she probably does not possess the vitality to bring all the others to maturity.

CIRCUMGENITAL GLANDS, OR SPINNERETS.

The study of the grouped glands or spinnerets (Plate XIV, Fig. 17 to 21), and their histology and function, offered an especial opportunity for some needed observations, and proved to be very interesting. The histology and actual function of these spinnerets have been subjects of much conjecture, although little real work seems to have been done on them. The reason for this is undoubtedly the fact that the glands (Plate XIV, Fig. 17-a) are functional for a very short period of time, and unless sections are made at this particular time, no glands can be found in connection with the grouped orifices. Sections made before the egg-laying period begins, cutting

squarely through these grouped spinnerets, often show a heavily nucleated invagination of the hypoderm, but aside from this no inkling as to the function can be ascertained. Just before the insect commences egg-laying, however, a white powdery substance can be found issuing from the openings, and sections made from the material killed at this time brought out the gland cells in their minutest detail. A slender duct (Plate XIV, Fig. 17-c) is found to connect each of the circular openings with the wax secreting glands. These units vary in number of cells from one or two to six or seven, each division possessing a prominent nucleus and uniting with the main duct by a slender, thread-like lumen. Between these ducts are numerous elongate supporting cells (Plate XIV, Fig. 17-b) which have no relation with the functions of secretion, except that they may aid in keeping the passageway open.

The spinnerets are circular, rather lens-shaped, and made of chitin, through which a minute pore is found connecting the cell and duct to the exterior. This opening seems always to be uniform in its makeup—a rosette with five small parts.

Prof. E. E. Green is the author of a general rule which can be applied to Coccids possessing these glands, that they are for the most part ovo-viviparous, or egg-laying, while those that do not possess these spinnerets are viviparous. I have made observations on a number of the local species and find the rule to hold true. I have also noted that the embryo reaches a greater state of development before the egg is deposited in the cases of those species in which there are very few spinnerets, than in those that possess a large number of grouped glands. In *Aspidiotus uvae* the circumgenital glands are found in very small numbers, two or three in a group, and the species is reported to be viviparous. The opportunity of studying a large series of these insects might reveal some very interesting facts. One can easily make a mistake in examining material for this phenomenon by using adult females which have died containing well developed eggs. The eggs are not destroyed by the death of the mother, but from them hatch young, around which is the shriveled skin of the mother, and through which there is no means of escape for the newly hatched insects. Such material when mounted impresses one as being of a viviparous form. Circumstances of this nature may be the explanation of some of the seeming exceptions to the rule.

Upon the arrival of the egg-depositing season the female assumes a different posture than is its earlier position, shortening itself to a considerable extent and appearing much more rounded (Plate XIV, Fig. 21). On the insect's taking this shape the vulva opens directly back instead of on the ventral aspect. With this change comes also a shifting of the normal position of the spinnerets (Plate XIV, Fig. 19) to the position shown in Fig. 20. In Epidiaspis the spinnerets consist of five groups, three anterior and two posterior, all about equidistant from the genital aperture. This shifting from the normal, together with an enlargement and infolding of the vulva, draws the glands to a position immediately surrounding and lining the opening. The eggs passing through this opening must necessarily pass over the glands, and in this passing the moist egg picks up a quantity of the powdery secretion that has exuded, more or less covering the newly deposited eggs (Plate XIII, Fig. 21). This powdery substance not only acts as a protection to the eggs, but also aids in keeping them from drying and sticking together and thus blocking up the limited space in which the insect has to store her ova.

THE MOUTH PARTS.

The mouthparts of the Diaspinæ are, as with the other subfamilies of the Coccidæ, hard to homologize with those of other insects. They are too minute to dissect and are always flattened out of shape when mounted, thus making a detailed description of the size and shape of the various parts a difficult thing to do with accuracy. For the most part this box-like framework of the Diaspinine mouth structure can be homologized with that for other Coccidæ, as described by Putnam, Mark, Moulton and others.

This framework is a very important structure in that it serves as a means of attachment for the powerful muscles that govern the sucking and swallowing apparatus. In the main, there are two arches (Plate XIII, Fig. 11) arcus superior (*a*), and arcus inferior, (*b*), which fuse to make a very rigid structure. Just below this box-like structure is a rostrum or mentum, conical in shape and attached at the base. This conical structure is covered with a chitinous layer and inside of this are a few short muscles, which are undoubtedly used

in the manipulation of the long buccal setæ, the four apparently modified mandibles and maxillæ, which are, in the case of this group of insects, extended into a long piercing beak. These four chitinous rods are arranged so that the plant juices pass up through the tube formed by their union. Attached behind the rostrum and lying free in the body cavity, is the setal pouch, extending well back towards the posterior end of the thoracic ganglion, into which the setæ are pulled when they are not in use.

At the base of the arcus inferior (Plate XIII, Fig. 11-b) is found a very interesting apparatus made particularly striking by its close resemblance to a piston valve, with all of its attachments, chamber, rod and head (Plate XIII, Fig. 12). Figure 13 shows a diagramatic cross section of this valve, showing inlet, 13-i, from salivary glands (Plate XIII, Fig. 11-d) and outlet into oesophagus 13-o.

Here again, in the impossibility of actual observation of the functioning, the interpretation of the actual function of the organ has to be based upon its structural make-up and the work that it apparently has to perform. Dr. Berlese is of the opinion that this pump is used for drawing the saliva from the large paired glands (Plate XIII, Fig. 11-e), and the arrangement of the ducts and the openings into the cylinder would seem to indicate this. Yet the rule for most insects with comparable organs is that these glands, as a result of an internal pressure caused by a continual secretion of the cells from within, or from muscular action, force the juices out. In the case of this insect no muscles are to be found that could perform this function, and, from the make-up of the glands themselves, they seem to the writer to be admirably adapted to operate through a pressure formed from within. Again, from the make-up of the long, slender, four-pieced proboscis, it would seem to be impossible to pump saliva into the plant tissues, for pressure from the inside would disrupt the tube. Necessarily, therefore, if there is a passage of fluid down this setal arrangement it would have to be done with little or no pressure. The presence of stained plant tissue at the point of puncture possibly indicates that some fluid does pass, as exemplified by the familiar reddish staining occasioned by the presence of the San Jose scale (*Aspidiotus perniciosus* Comst.)

on various fruit trees. This possibly might be explained as being the result of a mechanical stimulus and the disrupting of the cellular make-up of the plant, for the long chitinous rods that compose the mouthparts pierce and destroy a great many cells. This theory seems to be at fault however, in that all scale insects do not cause this phenomenon; for example, on the apple *A. perniciosus* causes a very distinct reddening while *E. piricola* does not.

The real function of the saliva is undoubtedly not to aid in the taking up of the plant juices, but to act upon these food properties after they have entered the insect's body. The relationship of the opening of the salivary glands to the oesophagus would seem to point to this. The food is poured into a common chamber at the base of the proboscis (Plate XIII, Fig. 12-c) passing on through the slender oesophagus (12-e) into the stomach.

The posterior part of the pharynx is a decidedly chitinized structure, apparently valvular, to which a number of powerful muscles (Fig. 12-f) are attached, and whose function it is to help force the food forward, through expansion and contraction of the walls of the oesophagus. These muscles are attached to the ventral wall of the insect, and undoubtedly act in conjunction with the large retractor muscles found directly above the pump-like cylinder of the mouthparts (Plate XIII, Fig. 12-b).

In the main the long, slender oesophagus resembles a capital letter U running forward from the chitinized pharynx parallel to the ventral wall (Plate XIII, Fig. 12-e) of the insect to about that point corresponding to the cephalic region of the chitinous box-like framework of the mouth-parts. At this point it turns toward the dorsal surface, passing between the two circum-oesophageal commissures close to the base of the brain. Here the tube turns parallel to the center, emptying into the stomach at a point just posterior to a vertical line that would run through the mentum (Plate XIII, Fig. 8). This tube is cylindrical in outline and it may be distinguished in sections from the surrounding tissue by the minute, circular cells, of which it is composed.

RESPIRATORY SYSTEM.

The Coccids possess a respiratory system that seems to be nearly uniform through the entire group, and that found in this species varies little from that of the larger representatives of the family. It consists, in Epidiaspis, of two pairs of stigmatic openings or spiracles, well guarded by hairs and spinneret-like glands which excrete a powdery wax over the exterior opening. These apertures (Plate XII, Fig. 6) possess rosettes (6-b) that make them indistinguishable from those that surround the vulva. A short tube leads from the stigma, opening into a chamber from which numerous tracheoles radiate, always, however, in a definite way so that all the individual insects of that species show the same characteristics and design (Plate VII, Fig. 2). For the most part these tubes are confined to the ventral surface, but can often be traced into the body cavity, surrounding the different groups of organs. The degree of diffusion of this system and its limit of ramification could not be determined, as only those tubes that possess a chitinization can be positively identified in the sections. In the larger, less specialized forms of Coccids, taenidial rings, the familiar characteristic of tracheal tissue are found, but in this species no such rings were noted, though a careful search for them was made. The characteristic trunk connectives joining the spiracles are very small and as a rule are unbranched. In some Coccidæ these have been found to be wanting, undoubtedly the result of degeneration.

THE CIRCULATORY SYSTEM.

The scale insects as a whole seem to be lacking in anything that may be called a definite circulatory system. No trace of a dorsal vessel can be found and no movement or pulsation of the body was noted that would indicate the presence of any such system.

EXPLANATION OF FIGURES.

Plate XII.

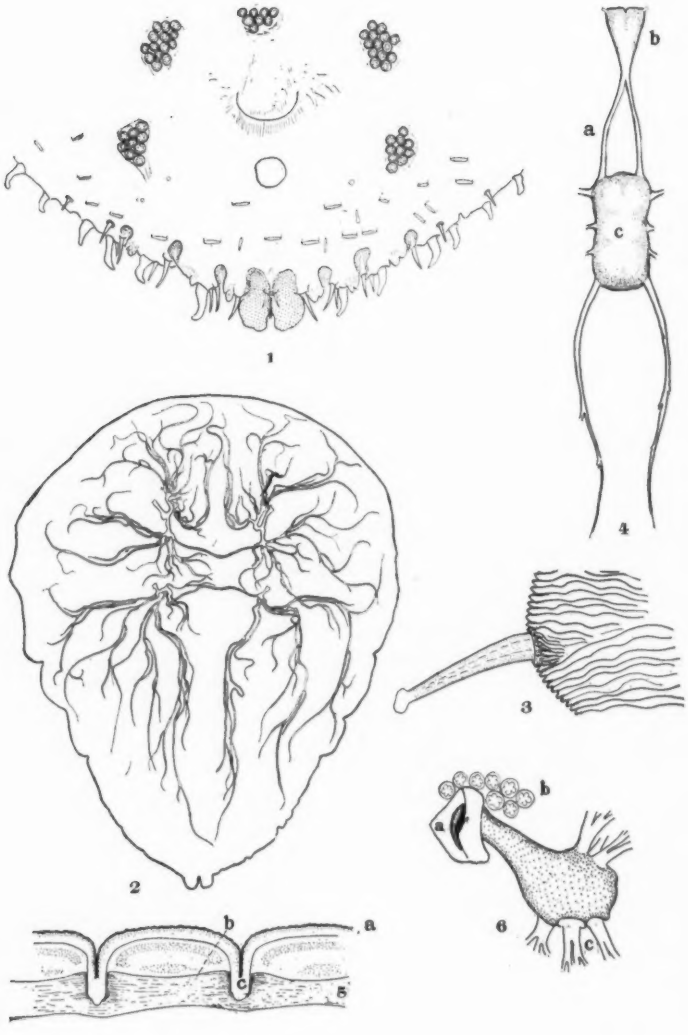
Fig. 1. Pygidium of adult female, dorsal surface with circumgenital orifice and glands showing through.
Fig. 2. Respiratory system of female insect, showing two pairs of spiracles.
Fig. 3. Glandular spine, used in spinning the shell. (cross section shown in Fig. 18-e).
Fig. 4. Nervous system. a. Circumoesophageal commissures; b. brain; c. thoracic ganglion.
Fig. 5. Cross section of segments. a. chitin; b. muscle; c. muscle attachment.
Fig. 6. Spiracle. a. opening; b. wax producing spinnerets; c. tracheal tubes.

Plate XIII.

Fig. 8. Sagittal-longitudinal section of adult female. a. stomach; b. malpighian tubules; c. rectum; d. vagina; e. ovarioles; f. thoracic ganglion; g. cephalic ganglion; h. salivary glands; i. setæ (rostral); j. setal pouch.
Fig. 9. Digestive tract. a. stomach; b. malpighian tubules; c. intestine; d. rectum; e. attachment filaments.
Fig. 10. Characteristic muscle structure found under chitinous covering.
Fig. 11. Mouth-parts and accessories. a. arcus superior; b. arcus inferior; d. valvular pump; e. salivary gland; g. costa inferior; h. costa superior; i. oesophagus (i. oesophagus drawn to one side); j. salivary ducts; k. setæ; m. muscle.
Fig. 12. Longitudinal cross section of mouth-parts. a. setæ; b. muscle; c. common chamber at base of setæ; the union point of oesophagus and duct leading from pump; d. salivary duct; e. oesophagus; f. muscles attached to base of oesophagus and to the body wall.
Fig. 13. Diagrammatic cross section of pump showing inlet and outlet. i. inlet; o. outlet.

Plate XIV.

Fig. 14. Ovaries, dorsal view. a. ovarioles; b. seminal receptacle; c. vagina; d. vulva.
Fig. 15. Ovaries, lateral view. (lettering the same as Fig. 14).
Fig. 16. Seminal receptacle. a. sperm cells.
Fig. 17. Sagittal section of gravid female cutting through caudo and cephalo-lateral circumgenital glands. a. wax glands with neuclei; b. supporting cells with neuclei; c. gland ducts; d. grouped gland orifices.
Fig. 18. Cross section of spinning glands that form the shell. d. dorsal spinneret with characteristic silk gland; e. spine-like marginal spinneret; f. silk gland; g. gland found in connection with the silk gland and supposed to secrete a cement-like fluid.
Fig. 19. Normal position of the vulva and circumgenital glands of adult female. a. vulva; b. anus.
Fig. 20. Shift in position of the circumgenital glands of the adult female during egg laying.
Fig. 21. Position of adult female during egg laying. a. normal position indicated by dotted line; b. position during the depositing of the eggs.



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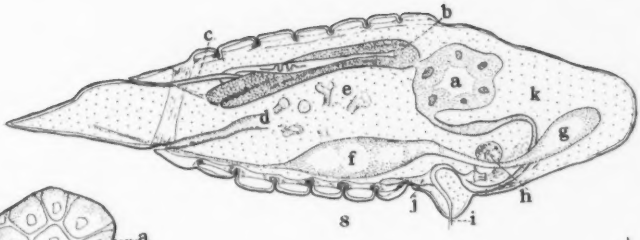

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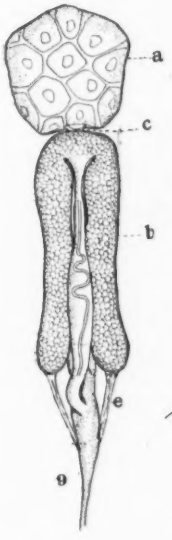

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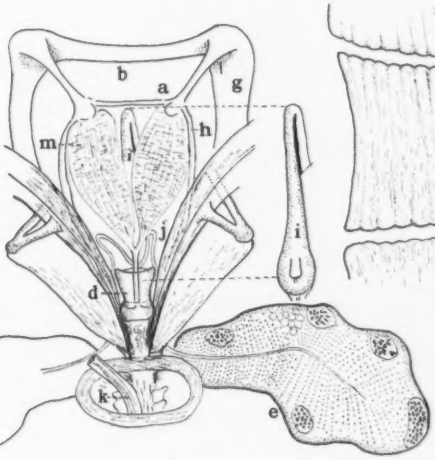

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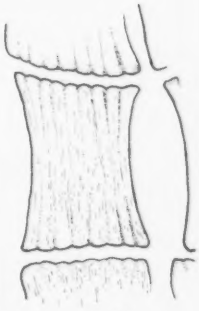

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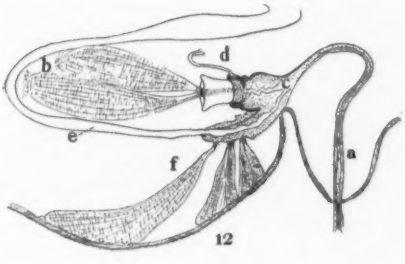

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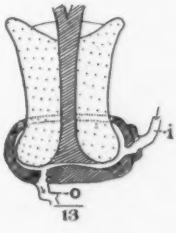

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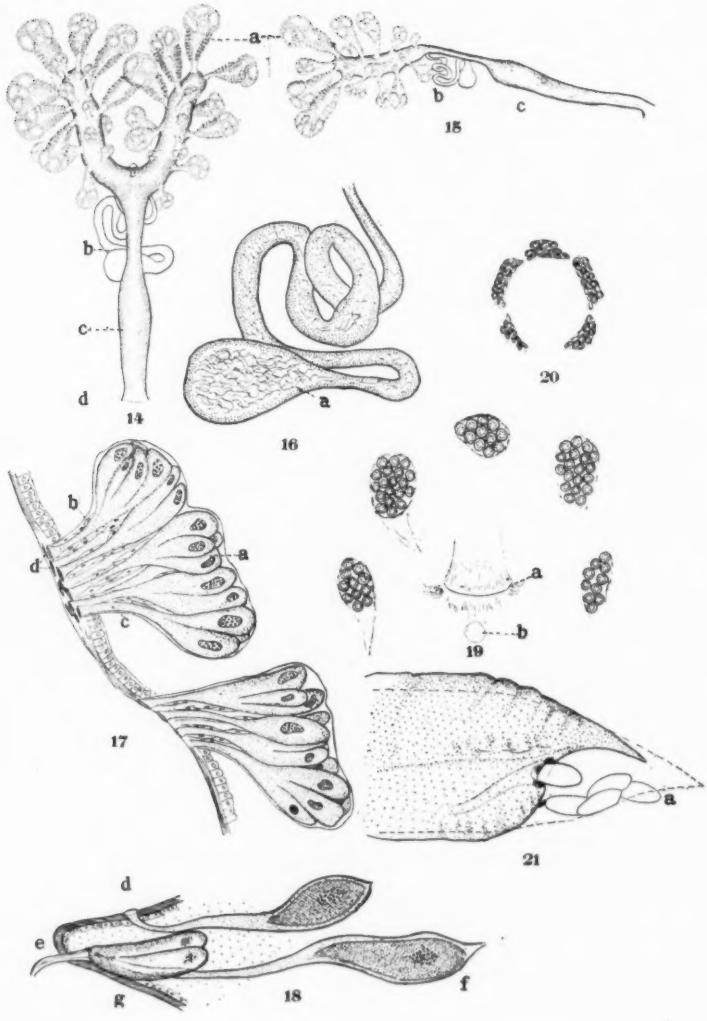
Leroy Childs.



Leroy Childs.

SOME PEMPHIGINAE ATTACKING SPECIES OF POPULUS IN COLORADO.

(Concluded from Vol VI, p. 493.)

By C. P. GILLETTE.

Thecabius populiconduplifolius Cowen, Plate XV, Figures 1 to 9.

Pemphigus populiconduplifolius, Cowen, Hemiptera of Colorado, Bull. 31, Colo. Exp. Sta., p. 115, 1895. Hunter, Aphididæ of North America, p. 79, 1901. Gillette,* Jour. Economic Ent. p. 355, 1909. Jackson, Cols. Hort. Soc. Vol. 22, p. 217, 1908. Contributions No. 29, Dep. Zool. and Ent., O. S. U., p. 217, 1908.

Pemphigus ranunculi n. sp., Davidson, Jour. Economic Ent. p. 372, 1910.

Pemphigus populiconduplifolius, Davidson, Jour. Economic Ent. p. 374, 1910.

Pemphigus californicus, Davidson, Jour. of Economic Ent. p. 414, 1911.

Pemphigus populiconduplifolius, Essig, Pom. Jour. Ent. p. 699, 1912.

Pemphigus californicus, Essig, Pom. Jour. Ent. pp. 699, and 700, 1912. Essig, Pom. Jour. Ent. p. 827, 1912.

Pemphigus populiconduplifolius, Patch,* Bull. 213, Maine Exp. Sta. p. 76, 1913.

The above literature may be briefly summarized as follows:

The original description by Mr. Cowen dealt with the alate fundatrigenia in the folded leaves of the cottonwoods with the mere mention of yellow apterous individuals, all from Colorado.

Hunter lists this species only.

The writer, in 1909, recorded the species from Massachusetts.

Davidson, 1910, described the alate and apterous forms taken in California from the buttercup (*Ranunculus Californicus*) to which he gave the name *ranunculi*, but which is probably *populiconduplifolius*, as Mr. Bragg and Mr. Asa C. Maxson have repeatedly traced this species to the buttercup in Colorado, where it seems to be perfectly at home. On page 374 of the same paper Davidson records *populiconduplifolius* in the folded leaves of *Populus trichocarpa* and mentions seeing the stem mother.

*These can hardly be *populiconduplifolius*, as the stem females were reported in both cases as being present in the colonies of developing lice, a condition which we have never found in Colorado where the types of the species were taken. Furthermore, I have a stem female from Massachusetts that was taken by Mr. L. C. Bragg, and it is readily distinguishable from any of the stem females that I have seen from Colorado by having remarkably thickened femora for all legs. The femora are very nearly twice as great in diameter as they are in the Colorado form and are of about the same length. Four winged migrants taken from *Populus balsamifera* (Acc. No. 47–10) in Maine by Dr. Edith M. Patch are before me, mounted in balsam. These seem to differ from Colorado examples principally by having weaker sensoria, which are also fewer in number, on the sixth joint of the antennæ. I will suggest that this eastern form be known as *Thecabius patchii*, though it does not have the typical habit of most known examples of this genus of having the stem mother in a gall by herself.

Jackson merely quotes Cowen's original description.

Davidson, finding the name *ranunculi* preoccupied, suggests *californicus* instead.

Essig lists this species both as *populiconduplifolius* and *californicus*.

Dr. Patch records several captures of this species in Maine on the leaves of *Populus balsamifera* and gives a figure showing the distribution of the wax glands of what she took to be the stem mother, and also an excellent figure of the antenna of the alate fundatrigenia, or summer migrant.

This is a rather common but not abundant species in northern Colorado and the writer has also taken it at Wheatland, Wyoming, upon a broad-leaved cottonwood.

Fundatrix, Figures 1-4.

The general color of the fundatrix is yellowish olive green, lightest over the middle area of the abdomen, more or less covered with a white powdery secretion and a few wax threads about the lateral margins and posterior portions of the body; head, eyes, antennæ and legs, including coxæ, black or blackish; in general form, broad oval; eyes small but very prominent; length 3.75 to 4.50, and width 2.50 to 3.00; hind tibia, .60; length of antenna about .70; 5-jointed; joints I, II and IV subequal in length, the fourth being a trifle the shortest; joint III barely as long as IV and V together with the spur; spur about half as long as joint IV; only permanent sensoria present and they are bordered with cilia. The arrangement of the wax plates upon the head and thorax is shown in figure 3, and is about as follows:

Head with a pair of large circular plates on the vertex between the antennæ; on the occiput a similar pair, not quite so large but somewhat wider apart, and midway between these a smaller pair, rather close together; on the prothorax four large plates in a transverse row, and two small ones in front of the middle pair; meso- and meta-thorax and joints 1-6 of the abdomen, each with a transverse row of 6 plates; joint VII with 4 plates; joint VIII with 2, and none on joint IX. It is not uncommon for two of these plates next each other to coalesce and so reduce the number.

The fundatrix is never found in the leaves folded along the midrib in which the other lice occur, but is always found in a narrow fold on the margin of one of the first leaves to open and upon the under side, see figures 1 and 5a. The second generation, almost as soon as born, leave the pseudo-gall of the fundatrix and travel to the tenderest little opening leaves at the tip of the twig, where they locate, several to a leaf, upon the lower or ventral surfaces where they begin to feed, causing the

leaves to fold along the midrib as shown at figure 5, b. Mr. Maxson in a letter makes the following statement in regard to his observations upon the early occurrence of the second brood:

"The first larvæ of the second generation were observed June 18th. These were traced to the young leaves at the tips of the branches where they located on the underside. These leaves began to fold along the midrib and in a few days typical *P. conduplifolius* galls were formed."

This second brood all acquire wings and leave the cottonwoods and go to the buttercups, *Ranunculus* sp., so far as our observations go. At the present writing, December 24th, there are several thrifty colonies in the laboratory on buttercups where they have been since the migrants were put upon the plants in July. They attack, not the roots, but the crown and leaves and stems near the ground. The buttercup seems to be a permanent food plant for this species, upon which it seems to be able to live continuously throughout the year.

COLLECTION DATA FOR FUNDATRIX.

Specimens in the collection have been taken as follows:

Ft. Collins, Colo.,			6- 2-13, L. C. Bragg,	*Populus occidentalis*	
"	"	"	6-12-13, L. C. Bragg,	"	"
"	"	"	6-16-13, L. C. Bragg,	"	"
"	"	"	6-20-13, L. C. Bragg,	"	"
Denver, Colo.,			6-25-13, L. C. Bragg,	"	"

Fundatrigenia.

The winged fundatrigenia taken from the folded poplar leaves is the form described by Mr. J. H. Cowen in Bulletin 31 of the Colorado Experiment Station, page 115, as follows:

"Length 1.8 to 2.2 mm. Alar expanse 6.85 mm. Nearly black, pruinose. The abdomen is deep green when the glaucus matter is removed by placing the insect in alcohol. Antenna 1.00 mm. long, joints slender, 5th and 6th with about six or seven annulations each; stigma short and broad; ungues usually with a constricted neck. Similar to *ramulorum* but larger and the antennal joint not nearly so strongly annulated."

In addition it might be said that the transverse sensoria (Figure 7) are not complete rings, many of them extending but a short distance, and especially is this true on joint III; on joint IV the number commonly varies between five and eight, and the same is true of joint V, while the number on joint VI is usually six besides the terminal or permanent one; spur, finger-like and about .05 in length, or about one-half as long as joint II; joints I and II equal in length, the former cylindrical, the

latter larger at distal end, each measuring .07; near the proximal end of joint III on the front side is a short tooth or spine; wings (Figure 6) clear, veins slender, stigma rather small. Described from seven types on one slide taken at Boulder, Colorado, June 23, 1910, by Mr. L. C. Bragg, along with a large number of co-types.

COLLECTION DATA FOR FUNDATRIGENIA.

Ft. Collins, Colo.,			7-11-12,	L. C. Bragg,	*Populus* sp.
"	"	"	8- 7-12,	L. C. Bragg,	" "
"	"	"	8- 6-12,	C. P. Gillette,	" "
"	"	"	7-12-13,	C. P. Gillette,	" "
Wheatland, Wyo.,			7-15-13,	C. P. Gillette,	" "
Boulder, Colo.,			6-23-10,	L. C. Bragg,	" "
Boulder, Colo.,			7- 4-11,	L. C. Bragg,	" "
Newcastle, Colo.,			7-23-93,	C. P. Gillette,	" "
Greeley, Colo.,			7-21-09,	C. P. Gillette,	" "
Lynn, Mass.,			6-27-09,	L. C. Bragg,	" "
La Salle, Colo.,			7-20-09,	C. P. Gillette,	" "
Eckert, Colo.,			6-26-10,	C. P. Gillette,	" "
Windsor, Colo.,			7-29-93,	C. P. Gillette,	" "
Niwot, Colo.,			7-15-08,	C. P. Gillette,	" "
Grand Jct., Colo.,			7-21-93,	C. P. Gillette,	" "
Veazie, Maine,			7- 5-10,	E. M. Patch,	" "
Delta, Colo.,			7-20-93,	C. P. Gillette,	" "
Niwot, Colo.,			7-15-08,	C. P. Gillette,	" "
Paonia, Colo.,			6-23-10,	C. P. Gillette,	" "

Mr. Maxson has given me the following statement in regard to the early appearance of the stem mother gall:

"The earliest date on which the galls were found was May 20th. On this date the lice were very small and appeared to be in the first stage after the egg, since no shed skins were to be found in the galls."

Alate Sexupara.

This form differs from the fundatrigenia by having joint II of the antenna (Figure 8) decidedly longer in proportion to its diameter; joint VI without transverse sensoria; joint V often without sensoria except the permanent one, but sometimes with one, two, or even three sensoria present; joint IV with but four or five sensoria, and joint V as long as joint VI with the spur.

This form has been taken at Fort Collins on several different dates during September on *Ranunculus* by Mr. Bragg, and about Longmont, Colorado, by Mr. Asa C. Maxson.*

*I am indebted to Mr. Maxson for the privilege of using the data that he has accumulated during the past two years from his studies of this insect. Mr. Maxson has also independently traced this insect to the *Ranunculus* from the cottonwood leaves.

Young larvæ.

The rather young larvæ of this species taken on *Ranunculus* are pale green in color and are heavily covered, especially over the abdomen, with fluffy wax threads. For full descriptions see Davidson's paper in Journal of Economic Entomology, 1910.

Pupæ on *Ranunculus*, pale yellow in color and very heavily covered with wax threads, especially over the abdomen.

Compared with Affinis.

This species is very close to *affinis* Kalt. of Europe, but seems to be distinct, and especially because of what seem to be rather marked differences in the antennæ. I have but a single European example of the alate fall migrant, sent me by Mr. J. J. Davis, from Dr. Tulgren, of Sweden.

I have found only six wax plates on the vertex of the fundatrix in twelve examples examined, while Tulgren gives eight for affinis; joint IV of the antenna is somewhat shorter in proportion to the other joints as compared with affinis in Tulgren's* figures, and joint V in the fall migrant commonly has two or three sensoria, while affinis is represented as having none.

Sexupara of affinis.

We have a good example of affinis from Europe, sent by Dr. P. van der Goot. Joints V of the antennæ have each one good transverse sensorium near the middle and one very small sensorium besides; joint IV has four well developed transverse sensoria on each antenna and is decidedly club shaped, being much heavier at the distal end. The same form of *conduplifolius* has joint IV more nearly cylindrical and usually with four well developed transverse sensoria, joint V usually with none but sometimes with one or two small sensoria, and joint VI with none.

The antenna of the virgogenia seems to agree with that of *affinis* as figured by Tulgren.

Asiphum sacculi n. sp., Plate XV, Figures 10 to 14.

I first saw the gall of this louse about eighteen years ago when on a mountain trip some twenty miles or more northwest of Fort Collins. I did not meet with it again until the present summer, when, on July 13th, I found two of the leaf pockets characteristic of this species in Estes Park on twigs of *Populus tremuloides* about six miles apart and at an altitude of about

*Aphidologische Studinen for Zoologi, 1905, Band 5, No. 14.

7500 feet. On August 9th, four more of the galls were taken near the Half-way House on Pike's Peak, at an altitude of about 9000 feet. In two of these galls there were no living lice. In each of the occupied galls taken (four), there was one large stem-female present, with a large number of her offspring in all stages of development up to the adult alate lice. There were no adult apterous lice and all that were half grown or more gave evidence that they were to get wings. In the breeding cages the alate lice began at once to deposit young with long beaks. In every case the lice were accompanied by a species of large black ant.

The Gall. An infested leaf becomes very much enlarged, and somewhat thickened with the edges turned in so as to make a heart shaped pocket, and the apex of the leaf is extended and turned back as shown in Plate XV, Figure 10. The color of the infested leaf is yellowish green, and lighter than the healthy foliage surrounding it.

Fundatrix. Figures 11 and 13.

A very large, oval, slatey gray louse, lightly covered with a fine white powder, and set everywhere with delicate gray hairs above and below; length of body about 4.50; width 4.00; antenna, .75; joint III longest and almost as long as joints IV and V together; permanent sensoria ciliated, joints I, II, and III with numerous delicate hairs; beak barely attaining third coxæ; hind femur .80; hind tibia .80.

Pupa. Figure 12.

The pupæ are quite dark in color, the abdomen being very dark olive green and the head and thorax a rather blue slated gray; the tarsi, eyes and terminal joints of the antennæ black. A conspicuous marking of the larvæ and pupæ consists of a row of five tufts of white waxy secretion along either lateral margin of the abdomen.

Fundatrigenia.

All the young of the fundatrix, the second generation, become winged and leave the galls. General appearance, that of a black louse; abdomen olive green; thorax, head, and antennæ blackish, or dusky; legs yellowish; tarsi dusky; wings a trifle smoky; the veins slender with a narrow dusky line on either side; stigma narrow, lanceolate, dusky, fork rising about midway on the cubital vein; length of body 3.50; wing 4.50; antenna (Figure 14) 1.00; joint III with 7 to 9 oval sensoria and a well developed spur near the base; joint IV, with two similar sensoria near the distal end; joints V and VI with the usual permanent sensoria only which are ciliated about the margins; joint III longest, fully as long as joint VI with the spur; joint V slightly longer than joint IV; cauda a broadly rounded lobe.

Habits for the remainder of the year unknown.

Mordwilkoja vagabunda Walsh.,* Plate I, Figures 15 to 20.

Byrsocrypta vagabunda Walsh, Proc. Ent. Soc. Pha., V. I, p. 306, 1862.

Pemphigus vagabundus, Walsh and Riley, Am. Ent. V. I, pp. 57 and 107, 1869; Riley, V. I, Mo. Rep. p. 120, 1869; Packard, Guide to Study of Insects, p. 524, 2nd. Ed. 1870; Thomas, Ent. Rep. Ill., V. I, p. 153, 1880; Oestlund, Aphids Minn. p. 22, 1887; Packard, Forest Insects, p. 434, 1890; Osborn, Cat. Hemip. Ia. p. 130, 1892; Cowen, Bull. 31, Colo. Exp. Sta. p. 116, 1895; Hunter, Aphid. of N. A., p. 79, 1901; Cook, O. Nat. V. IV, p. 118, 1904.

Pemphigus oestlundi n. sp., Cockerell, Ent. News, p. 34, 1906.

Pemphigus vagabundus, Jackson, Genus Pemphigus, Cols. Hort. Soc. XXII, p. 200, 1908.

Mordwilkoja oestlundi, Davis, William's Aphididæ of Neb. p. 4, 1911; Patch, Bull. 213, Me. Exp. Sta. p. 100, 1913.

The galls of this louse at the terminal buds of cottonwood twigs have occurred in greater or less abundance in at least one limited locality near Fort Collins, Colorado, for the past fifteen or more years. The section referred to is mostly rather low, moist land, along the course of an irrigating ditch and near the river. It seems strange that the galls should not have become more generally distributed unless the alternate host is largely limited to the area mentioned. I am assuming that there is an alternate host for the reason that the lice all become winged and leave the galls rather early in the summer. Most of them are gone by August 1st here.

The Galls, Figures 18, 19 and 20.

When growing, the galls are as green in color as the cottonwood leaves, and are, in fact, a transformed leaf in each case. On the inside of the green gall the main veins of the leaf are very prominent. Apparently these galls differ from others produced by Aphids by not having any opening to the exterior during their growth, but Mr. L. C. Bragg has discovered a small brown scale (Figure 18 A, and 20, b) at the base of the gall, which seems to be the apex of a folded leaf, beneath which is an opening to the interior and through which the blade of a penknife may be passed without cutting any tissue. This opening is so narrow that the lice do not escape by it. About the time that fully matured winged lice are developed in a gall (about July 10th to 15th,

*Professor Oestlund, in his Aphididæ of Minnesota, p. 22, states that Walsh's *vagabundus* is evidently something different from the louse that has since been known to be associated with the coxcomb gall. To be sure, September is late to take the migrants from these galls, and the measurements given by Walsh are too large for this species. But he evidently had a louse belonging to the Genus *Pemphigus*, as then understood, and in the Walsh-Riley paper published in Vol. I, of American Etomologist, page 107, the vagabond gall was figured, and both the winged lice and the apterous stem mothers from the galls mentioned. As Walsh at that time considered the winged lice from these galls the same as what he had described as *B. vagabunda*, it seems to me best to abide by his identification of his own species, and especially as we do not know any other species to which to refer his original description, which is quite inadequate for its identification anyway. I am therefore retaining the name *vagabunda*.

at Fort Collins), little star-shaped mouths (Figures 18 and 19, o) appear at the apices of the more prominent lobes thru which the alate lice escape. Many of them appear on a single gall as shown in Figure 18. The galls nearly always are from terminal buds, and whether one or more of the leaves form a single gall I have no certain knowledge, but apparently it is one in each case. Large galls measure as much as 80 to 95 mm. in greatest diameter, and about 50 to 60 in the greatest thickness.

The Fundatrix. Figures 15 and 16.

One fundatrix was found in every gall opened. General color of body yellowish green, the yellow tinge seeming to come from a large number of small embryos within; nearly unicolorous throughout, but a little darker along the lateral margins; legs and antennæ yellowish, the antenna blackish at tip; both antennæ and legs very short; joints of antenna 4; joint III about one-half the entire antenna in length; spur two-thirds as long as joint IV; permanent sensoria ciliated.

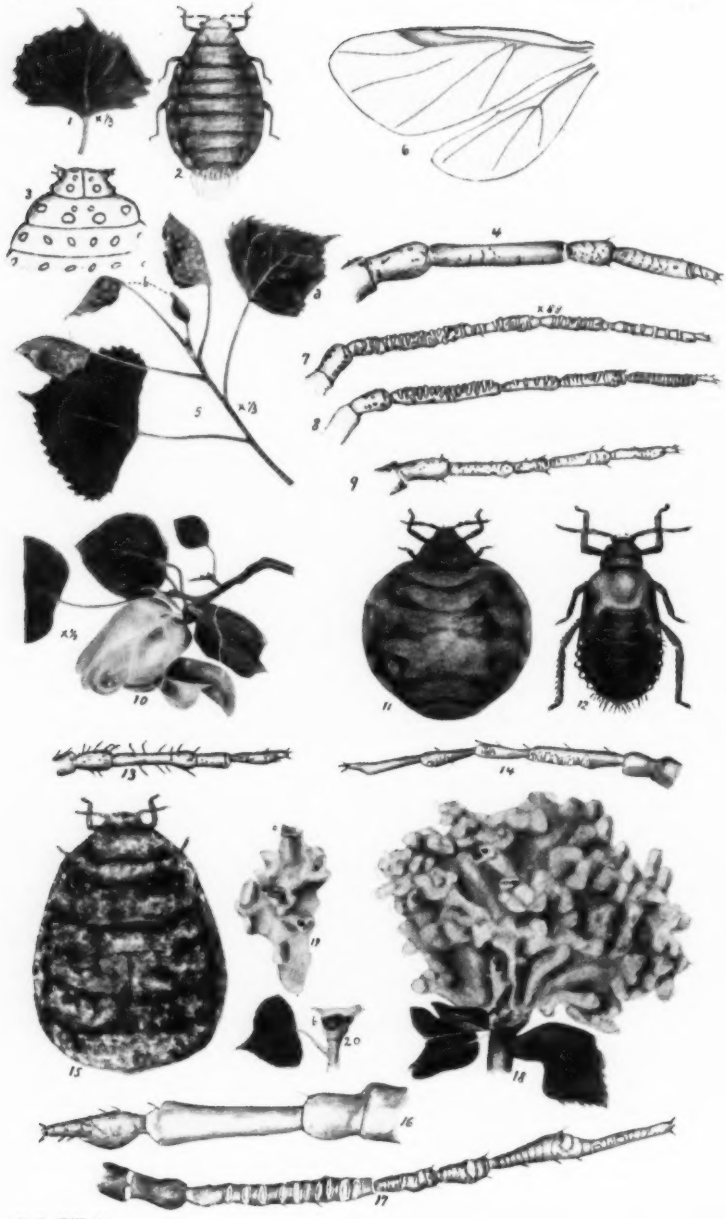
Length of body 5; width 3.70; constricted a little at base of abodmen. In general, stout, pear-shaped, the small end being at the head; covered everywhere with a light covering of white powder.

Young lice and pupæ in the galls are very pale yellowish and much powdered. There are a great number, possibly a thousand in all, in a gall and apparently the stem females were just in their prime and packed full of embryos on July 11. All of the offspring get wings when adult.

Fundatrigenia, Figure 17.

All alate lice with black head thorax and antennæ, and dark green abdomens, and the thorax and abdomen are heavily pruinose with more or less cottony threads towards tip of abdomen, making a tuft. Length of body 2.50 to 3.00 mm.; antenna .85; joint III as long as joints IV, V and VI to base of spur; joints IV and V sub-equal; spur about equal to joints IV and V together; a distinct spur near the base of joint III; sensoria on transverse ridges, but not surrounding the joints; joint III with nine to eleven sensoria; joint IV, two; joints V and VI with permanent sensoria, only; spur with two or three sensoria, usually three, scattered along its length; cauda very small, rounded.

Described from lice escaping from the galls July 11, 1913.



C. R. Gillette

Explanation of Plate XV.

(C. P. Gillette).

Plate XV. Figures 1 to 9, *Thecabius populiconduplifolius* Cowen: 1, stem mother gall on margin of leaf; 2, young adult stem mother; 3, showing wax plates on head and thorax of stem mother; 4, antenna of stem mother; 5, cottonwood twig showing the folded terminal leaves where the young from the stem mother gall have settled at b, and a stem mother gall at a; 7, antenna of fundatrigenia, or second generation lice; 8 antenna of alate sexupara or pre-sexual form; 9 antenna of apterous form found on *Ranunculus* during the summer and fall.

Figures 10 to 14, *Asiphum sacculi*, n. sp.; 10, pocket-like gall from Aspen; 11, fundatrix or stem mother; 12, pupa; 13, antenna of the fundatrix; 14, antenna of the fundatrigenia.

Figures 15 to 20, *Mordwilkoja vagabundus* Walsh: 15, fundatrix; 16, antenna of fundatrix; 17 antenna of fundatrigenia; 18, the vagabond gall containing fundatrix and young; 18, a, brown scale beneath which there is an opening into the interior of the gall; 19, a section of the gall showing oscula (o) that open for the escape of the mature lice; 20 (b) the closed mouth, also shown at 18, a.

Drawings by Miss Caroline M. Preston, except Figures 1 and 2, which are by Miss M. A. Palmer. Original.

DISPERSAL OF MUSCA DOMESTICA LINNE.

JAMES ZETEK, Ancon, C. Z.

The latter part of May, 1913, unusual numbers of flies appeared at the Isthmian Canal Commission hotels and commissary at Balboa, Canal Zone. An inspection revealed a pile of cow manure, etc., about 800 square feet in area, located at one corner of Ancon Cemetery, 2,500 feet distant in direct line from the hotel. This place is indicated by the letter "B" on the accompanying map. This manure was heavily infested with maggots, principally of *Musca domestica*, *Hermetia illucens*, *Volucella obesa*, and *Paralucilia macellaria*. Puparia were very abundant and adults in countless numbers. This was the only manure pile found away from the incinerators.

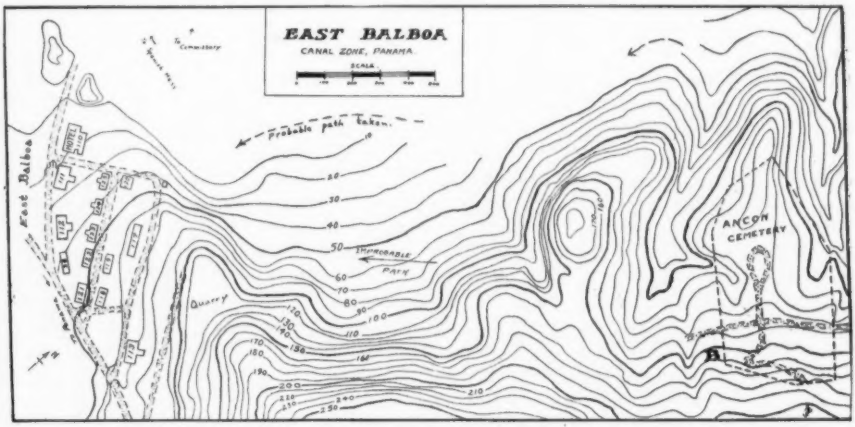


FIG. 1. Map of the region.

A pit was dug, into which was placed a small quantity of the infested manure. A cover of earth one foot deep was added as a protection from heat rays. Over this was placed a screened cage. On June 6th the cage contained about five thousand adult flies, most of them the common typhoid-fly. At 9:00 a. m. these were sprayed with an aquaeous solution of gentian-

violet, to which a small amount of gum tragacanth had been added. (See Annals Ento. Soc. Am. Vol. VI, No. 1, pp. 5–21). These marked flies were liberated at 9:30 a. m. at the same place.

At the hotels, commissary and a few private houses, tanglefoot paper was used freely, and this was afterwards collected by the writer and examined for the presence of any marked flies. The method used was to wet each fly with a solution of alcohol and glycerine. The marked fly became known by the resolution of the tiny crusts of anilin dye adhering to its body. Seventeen marked flies were thus recovered, viz:

East Balboa Hotel, 4 ♂ *Musca domestica* from paper exposed for 32 hours after the sprayed flies had been liberated at the cemetery.

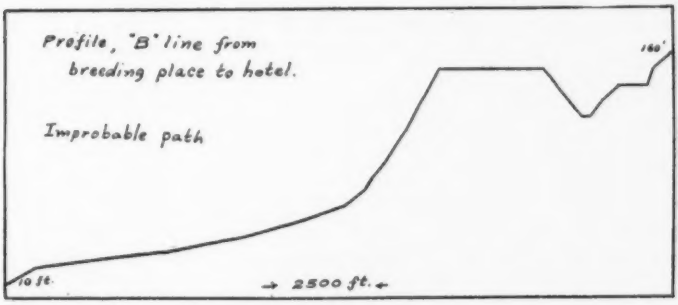


FIG. 2. Profile in direct line.

Spanish Mess, 9 (7 ♂, 2 ♀) typhoid flies from paper exposed 32 hours.

Commissary, 3 ♂ typhoid flies, from paper exposed 32 hours.

Spanish Mess, 1 ♂ typhoid fly, from paper exposed 75 hours (in reality 43 hours after last batch of paper was collected.)

No attempt was made to catch flies outside of these screened buildings, hence the 17 recovered adults represent only such as had gained entrance through holes in the screening or while the doors were opened and closed. The species found on the fly paper were mainly *Musca domestica* and *Hermetia illucens*, both of which breed freely in pit closets as well as in manure, and which were very plentiful upon cooked and uncooked food.

The probable path taken by the flies in this particular case was down the East and West gully along the cemetery, then along the lowlands to the Commissary and Hotels. The profile figured is made in a direct line from the breeding place to the hotel, but it seems hardly probable that this was the path actually taken. The former is the more likely one.

Thus it has been clearly shown that a mass of manure 2,500 feet from the hotels and 150 feet above them, was a menace to these places. The experimental results were augmented shortly after when this manure heap was completely destroyed. The flies at the Commissary and hotel quickly diminished in numbers.

CONWENTZIA HAGENI BANKS.

Life History Notes and Variations in Wing Venation.

By J. S. Houser, Ohio Experiment Station.

The species under consideration was first called to the attention of the Department of Entomology, of the Ohio Experiment Station, in November, 1912, by Mr. J. M. Keck, of Cleveland, who submitted the overwintering cocoons for determination. Dr. MacGillivray, to whom specimens were referred, pronounced them as belonging to the neuropterous family Coniopterygidæ. A little later, reared adults were sent to Mr. Nathan Banks, who gave the specific determination as *Conwentzia hageni* Banks.

At the time the material was taken the insect was in the larval stage, neatly encased in the double cocoon so well described by Quayle (Bul. 234, California Experiment Station). The gross appearance of the cocoon so closely resembles the compactly woven webs of some of the smaller spiders that it would be very easy to confuse the two, but as soon as a dissection is made, the double silk formation of the former very quickly separates them.

The cocoons were found most abundantly on a cherry tree some ten feet in height, the greater portion occurring in masses on the trunk. A considerable number, however, were to be found on the upper portions of the tree, where the crotches of the twigs seemed to be a favorite spot for their construction. Larvæ only were to be found, hence, it is safe to say the winter is passed in this stage. The three specimens upon which I was able to get exact records, changed from the larval to the adult stage in 16 days after being transferred to a temperature of 70° to 75°.

Since quantities of the overwintering eggs of the clover mite, *Bryobia pratensis* Garman, were found upon the tree which bore the Coniopterygid hibernacula, it is altogether likely that this pest supplies one of the principal sources of food for the insect. Quayle reports *Conwentzia hageni* Banks, feeding abundantly upon the citrus red spider, *Tetranychus mytilaspidis* Riley. Two visits were made last summer to Cleveland with the hope of learning something definite regarding the feeding habits of the larvæ; an additional visit was

made this winter in the hope of securing more of the hibernating material, but at no time were any of the insects to be found. The colony seemed to have disappeared entirely.

So much for general notes. The chief reason for directing your attention to the subject at this time is to point out some variations of wing venation which the writer observed, and in

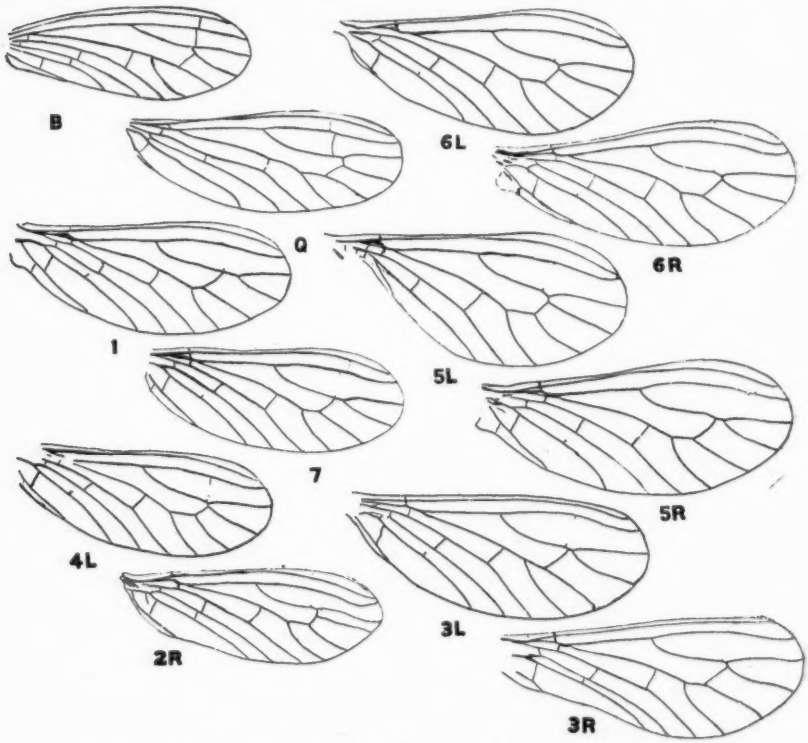


Fig. 1. *Forewings of Conwentzia hageni* Banks.

B. From Banks Proc. Ent. Soc. Wash., Vol. VIII; Q. From Quayle Univ. Cal. Publications, Bul. 234.

1, 7, 4L, 2R. One wing from each of four individuals in the author's collection.

6L and 6R, 5L and 5R, 3L and 5R. Left and right wings of three individuals in the author's collection.

so doing he does not wish to be misunderstood to be attempting to break down the validity of the specific determination, but wishes merely to record the variations from the standpoint of scientific interest. In the accompanying illustrations, B and

Q are copied from Banks, Proc. Ent. Soc. Wash., Vol. VIII, and Quayle, Univ. Cal. Publications, Bul. 234, respectively, while the remainder are from retraced photo-micrographic prints. Illustrations 1, 7, 4L, and 2R, are all from different insects. 6L and 6R; 5L and 5R; 3L and 3R, are three pairs of wings. All of my specimens were bred from the same lot of material and illustration No. 1 is made from a mounted slide used by Banks in making the determination.

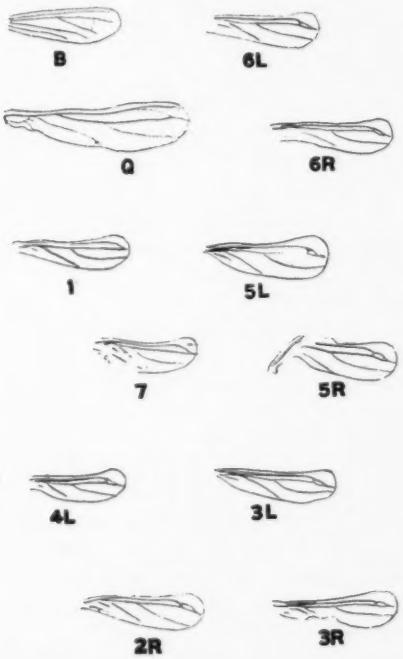


Fig. 2. *Hindwings of Conwentzia hageni* Banks.
The corresponding hindwings of the series of forewings shown in Fig. 1.

Banks refers to the variation in the placing of the cross-vein* from Sc to R1 and the one from the radial sector to $M1_{+2}$. The illustrations of the fore wing by Banks and Quayle do not differ materially, excepting that the cross vein between

* Whether this is a cross vein or SC_2 is an unsolved point. It is possible that an examination of pupal wing parts would decide the matter.

Cu2 and the first anal vein is not shown by Quayle. In all of my specimens the cross vein from Sc to R1 is either exceedingly faint, or wanting entirely; sometimes being indicated by a thickening of R1 at the point where it might be expected to occur. Cross vein from R1 to radial sector is usually indicated by a sharply defined stub, extending about one-seventh of the distance upward from the radial sector, and is sometimes indicated above by a less sharply defined stub extending downward. The position of the cross vein from the radial sector to M1+2 is exceedingly variable, sometimes joining above to R2+3+4+5, and sometimes to R4+5. In some cases, such a difference occurs between the wings of the same insect as in the case of 5L and 5R; 3L and 3R. In the majority of cases the cross vein between Cu2 and the 1st A is represented by a short stub only, which arises from 1st A.

The variations in the venation of the hind wings are even more striking than in the fore wings, especially regarding the types illustrated by Banks and Quayle, when compared with my photographs. Banks illustrates a cross vein between R1 and the radial sector; Quayle shows a long oblique cross vein between Sc and R1; while in all my specimens Sc bends sharply downward towards the distal end and joins R1. Some wings have a short cross vein joining Sc and R1 near the point where the former joins the latter, forming a very peculiar little cell.

None of the longitudinal veins of the hind wing are shown by Banks as joining the outer margin which agrees with Enderlein's generic description of *Conwentzia*. Quayle shows radius and its branch; media and cubitus joining the margin. In my specimens Cu R1, if not joining the margin, approaches perilously near to it, while the radial sector unquestionably joins the margin and cubitus joins in some instances.

An additional and final comparison may be drawn between the comparative size of the fore and hind wings as represented by the drawings of Banks and Quayle and my photographic series. In the entire set of reproductions, the size ratio between the fore and hind wings is truthfully maintained, hence, by collating wings B, Q and 1, of the fore and hind series, it will be seen that no very great difference obtains regarding the size of the forewings, whereas the hind wing of Quayle's specimen is markedly larger than either of the others.

A COMPARISON OF NATURAL CONTROL OF TOXOPTERA GRAMINUM IN SOUTH AFRICA AND THE UNITED STATES.

By WILLIAM MOORE,
Asst. Prof. of Entomology, University of Minnesota.

During the past year, the author, while engaged as Lecturer in Entomology at the Potchefstroon School of Agriculture, spent considerable time in studying Toxoptera graminum in South Africa and its control there by natural enemies. As the results obtained have been somewhat different from those obtained in the United States, it is thought that a comparison of the conditions and the results would be of interest to Entomologists.

Toxoptera graminum is found over certain large areas in South Africa but attracts the greatest amount of attention in the Orange Free State, Basutoland, and the western portion of the Transvaal. It seems to have been present, at least in the Free State, for many years, since the older farmers can remember the pest as long as they have been farming in the eastern portion of the Free State, known as the Conquered Territory. The earliest definite record was 1896, which year is distinctly remembered by a farmer who lost his entire wheat crop in that year. In the higher portions of South Africa, i. e., an elevation of more than 5000 feet, Toxoptera is either not present or is not present in numbers sufficient to attract the attention of the farmer. In the lower coastal regions, it also appears to be absent as, for example, along the coastal region of Natal. It is probable that the increased importance of Toxoptera during later years has been due to the destruction of the locusts which formerly swarmed over South Africa. There is little doubt but that the locusts destroying the grain and incidentally destroying Toxoptera were responsible for the prevention of what might have been a serious attack during that year. Since the locusts have been destroyed, Toxoptera has had a better opportunity of showing the injury of which it is capable.

In South Africa, there seem to be two forms of Toxoptera under normal conditions, namely, the winged migratory females and the apterous, viviparous females, the males and the

oviparous females apparently being absent. As these forms are too well known to entomologists to require a description, only a few notes concerning their migration and food plants will be given.

Toxoptera, during the summer time, from about the middle of November until March, live upon various grasses and volunteer grain plants. The most important grasses in this connection are Johnson's Grass (Sorghum halepense), Goose Grass (Eleusione indica), Sweet Grass (Panicum laevifolium), Teff, Millet, Indian Corn, and Kaffir Corn (Sorghum Sp.). The Blue Grass, upon which it is found so frequently in the Free State, is not Andropogon hirtus, as reported by C. B. Van der Merve and mentioned by F. M. Webster, but is the Sweet Grass Panicum laevifolium, which is usually called Blue Grass in the Free State and Sweet Grass in the Transvaal. There are a number of grasses in South Africa known as Blue Grass, without a distinctive common name. From March until June or July, Toxoptera is found upon green forage crops such as barley, rye, and oats. These give it an opportunity to exist from the time that the grass becomes too old for it, or is killed by the frost, until the main grain crop of the year is up, about June or July. It is also very abundant during the winter time upon Rescue Grass (Bromus willdenowii).

It exists on the winter grain until about September or October when it changes to its summer host plants. The severe attack usually occurs either in March on the green forage crops or in July, August, or September, on the main grain crops. The most critical time of the year for Toxoptera in South Africa is in October or November, when it becomes necessary to change from the grain field to its summer grasses. The winters in South Africa are dry and, if rains do not occur before October or November, the summer grasses do not come up, while, on the other hand, the grain rapidly ripens, becoming unfavorable for Toxoptera. At such a time, no doubt, large numbers of Toxoptera are lost in making this change. Some of these are always saved by their ability to live upon the roots and underground shoots of Johnson's Grass where they are attended by a common, grayish-brown ant, *Plagiolepsis dustodiens*. This is interesting, inasmuch as H. Maxwell-Lefroy, Government Entomologist of British India, reports Toxoptera

graminum seeking shelter in the depths of the grass roots. They were found in this situation in South Africa in many cases all through the summer, probably thus obtaining some protection from the hot rays of the sun. The forms on the roots were quite white but when such were removed to wheat plants in the Insectary, either they or their off-spring assumed their natural color and it was found that the colonies on the roots tended by the ants consisted of both Toxoptera graminum and also Aphis maidis. These two species were also frequently found associated upon the summer grasses, especially Panicum laevifolium, Indian Corn, and Kaffir Corn.

As to the rate of reproduction of Toxoptera in South Africa, it might be stated that it is about the same as it is in the United States. In South Africa, migrations over large areas as reported in the United States, are not so apt to occur. Similar migrations on a smaller scale, however, do occur. Usually, it is from the dryer portions to the wetter portions of the country, inasmuch as Toxoptera will kill the grain sooner, under dry conditions. There have been no reports of extensive migrations in the Transvaal but they are known in the eastern districts of the Orange Free State. Farmers about Ficksburg, O. F. S., state that the swarms occur coming from the west late in September or October. As the natives of Basutoland do not raise grain for green forage crops, and as the grass is always dead long before the winter grain comes up, most of the Toxoptera injuring the grain in Basutoland must come by migrations from the Orange Free State. It is difficult to get any definite data on this point from the natives but they seem to know that something of the sort occurs.

In South Africa, two internal parasites have been found which are capable of breeding in Toxoptera. The first (Aphidius phorodontis (?) is commonly bred from Toxoptera in the field. Another species is Diaeretus rapæ and has been bred in the field from both the Cabbage Aphis (Aphis brassicæ) and the Green Peach Aphis (Myzus persicæ), both occurring upon cabbages but in the Insectary this species was also bred into Toxoptera. It is doubtful, however, whether this species would normally be found breeding in the field upon Toxoptera unless the grain field was quite close to a cabbage patch. Aphidius phorodontis has been bred from the Green Peach Aphis

(Myzus persicæ), the Black Peach Aphis (Aphis persicæ-niger), the Corn Leaf Aphis (Aphis maidis), Yellow Aphis on Milkweed (Aphis nerii), a reed Aphis (Hyalopterus arundinis) and the Black Bean Aphis (Aphis rumicis).

Aphidius phorodontis, however, seems to be capable of destroying just as many individuals of Toxoptera as is Aphidius testaceipes. The average period of development from egg to adult seems to be about ten to twenty days. The maximum number developed from one female was 286 which is only 15 below the maximum obtained by Mr. Parks in the United States Department of Agriculture. It is safe to assume that in "stinging" so many that it must often occur that two or more eggs are laid in one individual Toxoptera so that it is safe to assume that Aphidius phorodontis lays 300 or 400 eggs. There seem to be about 70 per cent. of the parasites females if the mother Aphidius has been fertilized. It was also shown that one male would fertilize more than one female but time did not permit of finding how many females might be fertilized by one male. If the female was not fertilized, she would lay eggs and the proportion of the parthenogenetic off-spring were about 70 per cent. males.

When an infested grain field is examined, even though species of Aphidius are present, one never finds a large number of parasitized forms of Toxoptera upon a weak plant such as is shown to be the case in the United States. Probably one wheat plant would, at the most, not have more than ten parasitized forms upon it. Besides this species of Aphidius, there are three different species of ladybirds which play an important part in controlling Toxoptera in South Africa. The first and most important is the Black Spotted Ladybird (Adalia flavomaculata), the Red Spotted Ladybird (Chilomenes lunatus), and the Black Ladybird (Exochomus nigromaculatus). These ladybirds are a most important factor in controlling Toxoptera. It is seldom that one finds a field badly infested in which ladybirds are not present and rapidly destroying Toxoptera. The life history of Adalia flavomaculata was worked out rather completely.

Under favorable climatic conditions, the eggs hatched in from five to seven days from the time they were laid. The larvæ feed for a short time upon the eggshells but soon begin feeding

upon the Aphids. The larval stage lasts from about ten to thirteen days during which time they eat, on an average, 320 Toxoptera per larva,—that being about 26 to 28 Toxoptera per day. The pupal stage lasts six to 10 days and about 30 to 35 days elapses from the time that they emerge until they lay eggs. During this time, they eat about 825 Toxoptera per ladybird, making an average of about twenty-five per day to each ladybird.

In this species, all the eggs seemed to be laid during one period which lasted for about a week to ten days, during which time they laid about 100 to 150 eggs. After having completed the egg-laying, they live for some time before they die. The Adalia seems to live about three to four months,—the males dying first. In one experiment, the larvæ were hatched from eggs laid on the 10th of October, 1912, the last ladybird died on the 24th of February, 1913, and the average number of Toxoptera destroyed was 2844 per ladybird. In this experiment, the ladybirds were given as many Aphids as they could eat. When the Aphids were scarce, the ladybirds would not pass as rapidly through the different stages and the number of eggs laid by the adults had a direct bearing upon the quantity of food present. When the food supply runs short, the eggs which have already been laid will be eaten while even the larva will eat each other and the adults will eat the larvæ.

In the case of the Red Spotted Ladybird, we have a larger species, being about 3-10 inches in length and nearly as wide,—hemispherical in shape. The adult ladybird of this species will lay from 150 to 250 eggs during her life. The egg-laying period seems to be divided into several different stages. In feeding experiments with the larvæ of this ladybird, it was found that during the ten days of its larval existence, each larva eats about 440 Aphids. Another interesting point is that the normal life of the Red Spotted Ladybird is much longer than that of the Black Spotted,—being about four to six months.

Both of these ladybirds were found to be parasitized by a species of Dinocampus. The parasite laid its eggs in the larva and in some cases, probably, in the pupa. The cocoon of the parasite is formed underneath the adult ladybird and it seems that the ladybird always reaches the adult stage before the larva of the parasite emerges from the ladybird's body to form

its cocoon. This species of Dinocampus seems to consist entirely of females, as no males were found, even though individuals were bred from females in the Insectary.

The third species of ladybird is much smaller than either of the other two but has a life-cycle similar to the others. No exact records were obtained as to the number of Aphids eaten but it was found that the average life, from the egg until the adult dies is about five to six months. One peculiarity noted was that the eggs were not laid on end as is generally the case with ladybirds, but rested on their sides on the leaf in little heaps. This little ladybird is very severely parasitized by a Chalcid belonging to the genus Homalotylus. The parasite is usually bred from the larva collected in the field. In the month of October, about 25% of the larvæ seemed to be parasitized. From three to seven eggs are laid by the parasite in one larva and the ladybird larva usually hangs itself up as though about to pupate before dying. The larva of the parasite pupates in the dead body of the ladybird larva.

This Chalcid will also breed in captivity in both the other species of ladybird, but has not been bred from either of them in the field.

The little Black Ladybird is most beneficial during the spring and autumn when the cold affects the parasite more than it does the ladybird. During the summertime the ladybird becomes more or less rare, no doubt due to the parasite effectively controlling it.

The ladybirds seem to be of greater value in controlling Toxoptera in South Africa than in the case with the ladybirds which feed upon Toxoptera in the United States. The fact that Aphidius does not immediately destroy Toxoptera but allows it to live for a few days, during which time, if the Toxoptera is an adult, it will produce young, detracts from the value of Aphidius, when compared with the ladybirds. An example will show better what is meant. Take a plant with 200 Aphids, 50 adults and 150 young, under control conditions and introduce a female parasite. There is then a possible chance that all the Aphids on this plant will have an egg laid in them but this will not always happen, inasmuch as two or more eggs would be laid in one Toxoptera while others would escape the parasite. Granting, however, that all of them contained eggs and would

die in about seven days, it is found that the fifty adults would have produced about 500 young during the first two or three days after the egg of the parasite had been laid in their bodies. These young would have a very small chance of being destroyed by the parasite and would reach maturity after the death of their mothers or about three or four days before the offspring of the Aphidius which had "stung" the 200 Aphids, had emerged. During these three or four days, they would be producing young, so that when the Aphidius emerged, there would be between 2000 and 2500 Toxoptera on the plant.

When the offspring of this female parasite emerged, however, the chances are that all the Toxoptera would be destroyed. From the above, it will be seen that starting with one Aphidius and 200 Toxoptera on one plant, there would be at the end of about fourteen days, 2000 or 2500 Toxoptera, while the plant would not be entirely clean of Toxoptera until about twenty days had elapsed. On the other hand, if an adult ladybird had been introduced with the 200 Toxoptera, every individual would have been cleaned away from the plant in ten days at the most, while it probably would have been within five or six days. When the ladybirds are present in the field with Aphidius, another fact must be remembered, namely, that if Aphidius has "stung" a number of Toxoptera and a ladybird later ate these parasitized Toxoptera, the ladybird is also destroying the parasites as well as the Toxoptera. This is even carried further by the ladybirds, inasmuch as they will eat the parasitized forms even when the Toxoptera is dead, and the parasite is in the pupal stage. It is no doubt due to this reason that one does not find wheat plants covered with parasitized forms in the field in South Africa, as one does in the United States. When a number of infested wheat plants were enclosed with wire netting so that Aphidius could gain entrance, but a larger insect, as a ladybird could not, it was soon found that the wheat plants were crowded with parasitized forms similar to those described by Webster as occurring in the United States. There seems to be but little doubt that in South Africa, the ladybirds are of more value in combating Toxoptera than Aphidius. This is of particular interest inasmuch as an attempt is now being made to introduce *Aphidius testaceipes* into British East Africa where Toxoptera is found near Njora.

If *Adalia flavomaculata* and *Chilomenes lunatus* are found there, it is very doubtful whether the value of *Aphidius testaceipes* will be as great as it is in the United States.

The Little Black Ladybird, *Exochomus nigro-fasciatus*, is reported from the Soudan and it, no doubt, occurs in British East Africa. Several Aphid-eating Ladybirds have also been reported from the Soudan as being particularly beneficial in controlling an Aphid on Kaffir Corn.

Another point in favor of the ladybirds is that they will breed and will control Toxoptera at a lower temperature than Aphidius. All the stages are greatly retarded, however, by cold and the adults do not seem to lay eggs. It seems from experiments carried out that more Aphids are required per ladybird in their lives when it is cold than is the case at a warmer temperature. Larvæ of Adalia lived for about thirty-five days at a mean daily temperature of from 45 to 55 degrees and ate during that time 416 Aphids per larva, as compared with 319 in the summer time in a period of thirteen days. At a lower temperature, therefore, the larva eats only about half the number of Aphids per day, but feeds for about $2\frac{3}{4}$ times as many days.

Besides the ladybirds, one finds a Syrphid Fly (*Xanthogramma scutellare*) does considerable good in controlling Toxoptera. The Syrphid also incidentally destroys Aphidius by destroying Toxoptera which contain the eggs or larvæ of Aphidius. In no case, however, were they found destroying the parasitized forms of Toxoptera. A leaf which has been cleaned by Syrphid Fly larva will be found to have a few parasitized forms of Toxoptera remaining on it. This, however, would not be the case if the leaf had been cleaned by a ladybird or a ladybird's larva.

This Syrphid Fly is also retarded in its good work by a parasite Bassus laetatorius. This parasite very effectively controls the Syrphid Fly when the latter becomes very abundant in the field. The most beneficial work of this Syrphid was found to be in fields which were just becoming infested with Toxoptera migrating from some other place. This Syrphid seems to be the first to find the Aphids in their new home and commence the work of destruction, but as soon as the

Syrphids become overly abundant in the field, the parasites find them and they so reduce their number that they are of very little value.

In conclusion, it might be stated that the cause of a bad outbreak of Toxoptera in South Africa is due to the same causes as a bad outbreak in the United States. If the early winter months are abnormally cold, while the middle months of the winter are warmer than the average, followed again by a cold spring, there is a long period of from five to six months during which time Toxoptera breeds more rapidly than the ladybirds or Aphidius, the result being a bad outbreak of Toxoptera.

Another factor which sometimes tends to cause bad outbreaks is long periods of drought since, under such conditions, plants are not able to withstand the number of Toxoptera which normally they could carry without showing any ill effects, thus dying, not entirely from injury by Toxoptera, but, with drought as a secondary factor. If such land be irrigated, the plants are enabled to survive the attack.

REPORT ON PARASITES.

DR. L. O. HOWARD.

The work on parasites and predatory enemies of the gipsy moth and brown-tail moth has continued along the same lines as during the previous year, except that no attempt has been made to import additional parasites this season. The material imported from Europe last year has been colonized and an effort has been made to determine the extent to which the species secured have established themselves in the field.

Owing to the fact that one of the imported egg-parasites of the gipsy-moth, *Anastatus bifasciatus*, breeds very slowly, extensive collections were made during last winter of parasitized gipsy moth egg-clusters from colonies that were planted in previous years. From this material it has been possible to liberate 1,500,000 parasites of this species, and these have been placed in 1,500 colonies in sections where the insect had not become established. Eight hundred colonies were planted in towns along the western border of infestation, and the balance were liberated in a number of towns in the northern part of Massachusetts. During November of this year collections were made in New Hampshire in the colonies of Anastatus that were planted a year ago, and examination showed that these plantings were practically all successful although the spread has been slow. From these collections about 100,000 parasitized eggs were secured and will be used for colonization in New Hampshire next spring.

Investigations have shown that another egg-parasite of the gipsy moth, namely *Schedius kuvanæ* has become perfectly established in several colonies where it has previously been planted. During the past year there has been a decided increase in the abundance of this parasite, and in some cases it has spread nearly a mile and a half from the limits of its last year's spread. The parasites attacking the caterpillars of the gipsy moth have been found more abundantly than during the previous year.

Compsilura concinnata, a species of Tachinid fly, was very abundant during the summer of 1912, especially in the territory which was longest infested by the gipsy moth, and

continued to spread during the past summer. It has not been so abundant in the oldest infested territories as in some of the outlying colonies. Collections of more than eleven hundred gipsy moth caterpillars made in four towns in central Massachusetts show a parasitism by this species of over 40 per cent, while similar collections in the central infested area have indicated an average parasitism of about 5 per cent. It is probable that the decrease in parasitism in the old infested area, as far as this species is concerned, is due to the fact that gipsy moth caterpillars are not nearly as abundant as they were during the previous year, and also because of the enormous numbers of the American tent and forest caterpillars which were present in this region and which are also attacked by this parasite.

Limnerium disparidis and *Apanteles* species were received from Europe for the first time in 1911 and were planted in several badly infested gipsy moth colonies. Both species were recovered during the summer of 1912, which indicated that it is possible for the insects to withstand our cold winters. In the case of the latter species, as high as 7 per cent of parasitism of gipsy moth larvæ was found. The present summer the Limnerium was recovered from a single locality where the species was liberated in 1911. Although it has evidently become established, it has not thus far shown marked ability to increase in the gipsy moth infested area in New England.

Another species of Apanteles, namely *A. lacteicolor*, an important parasite of the brown-tail moth caterpillars, has been recovered in large numbers and has been found to attack gipsy moth caterpillars in widely separated regions. This species seems to be multiplying more rapidly than any of the other Hymenopterous parasites of the gipsy moth. In order to colonize this species over as wide an area as possible, an arrangement was made with the State Entomologist in New Hampshire and the Superintendent of Moth Work in Maine to liberate as many colonies as possible along the outskirts of the area infested by the brown-tail moth in those states. Small collections of gipsy moth larvæ were made at Melrose, and in some cases ten per cent of the larvæ were killed by this species. In several localities in New Hampshire the past summer cocoons of this parasite were very abundant, and

several hundred were easily collected for experimental work. They were taken for the most part on the foliage of trees and attached to dead caterpillars.

The Calosoma beetle (*Calosoma sycophanta*) has been observed in large numbers in towns where bad colonies of the gipsy moth were present. It has not been possible to obtain definite records of the amount of benefit derived from this species or of its abundance, except in cases where trees were burlapped, as these bands furnish favorable hiding places for the caterpillars and are favorite locations for the beetles and larvæ to obtain food. In such cases, where caterpillars were abundant, twenty or more of the Calosoma larvæ have frequently been found under a single burlap band on an average sized tree. As they feed upon the pupæ as well as upon the caterpillars, the amount of benefit derived is very great, although it is difficult to figure the percentage of larvæ killed.

From collections made during the winter of 1912-13 it was determined that *Monodontomerus aereus* has spread over practically the entire territory now known to be infested by the brown-tail moth. It was not found in as large numbers as during the previous year. *Pteromalus egregius* has been found widely scattered over the area infested by the brown-tail moth, and its numbers are slowly increasing, judging from the records that have been secured from sample collections.

There is thus no doubt that a number of the imported species are thoroughly established and that they are increasing each year, and further that many hundreds of thousands of caterpillars were killed by them during the past summer.

NOTES ON SOME OLD EUROPEAN COLLECTIONS.

By H. T. FERNALD, Amherst, Mass.

There seems to be little on record in this country about the older European collections of insects. Possibly the facts are more or less common knowledge, but if so, a rather careful search has failed to produce much of value. Yet in these days when types are coming into such prominence as the "court of last resort"in our attempts to finally establish specific identities, the location of these collections, their state of preservation and any facts which may enable workers to find the specimens they desire to examine, should be on record. The following notes are therefore offered in the hope that they may be of some use at least, to those who expect to study abroad.

The collection of Linné as including the first insects to which the binary nomenclature was applied, is of much interest.

This collection appears to be now in part at Upsala and in part at London. The material at Upsala was for many years at the royal castle Drottningholm, but in 1803 what remained was sent to the Academy of Science at Upsala by Gustav Adolph IV, where it was arranged and labelled by Linnaeus' student, Thunberg. This was probably the portion which constituted the collection belonging to the Queen of Sweden, and of which Clerck illustrated the Lepidoptera in his Icones Insectorum, and to judge from this, and such statements as are available, consisted only of Lepidoptera.

In the zoological museum of the University of Upsala are two wooden cases of Linnaean Hymenoptera which have recently been examined by Schulz (Berl. Ent. Zeits., LVII, 55, 1912), and reported upon.

Linné's private collection was sold by his wife after the death of her son in 1783, to Dr. James E. Smith, of England, for one thousand guineas. It consisted of his books, correspondence, insects and plants, and reached London in 1784.

In 1788, due largely to the influence of Smith, the Linnaean Society was established, and this material is now in charge of this society which is located at Burlington House, Piccadilly,

London. It is kept in the original case, in which are drawers containing the insects, while others contain the plants and books. Smith long retained the collection and being a collector, received many specimens from friends. These it would seem, he placed in the drawers with the Linnaean specimens, so that as it now stands, the collection contains many specimens not properly belonging with the Linnaean material. This unfortunate condition is liable to cause confusion in any examination, as the Linnaean specimens can only be distinguished by the handwriting on the labels.

The work of Fabricius can be found in a number of collections in Europe. His personal collection is in the Zoological Museum of the Univeristy of Kiel, but he made numerous visits to different museums, naming the insects where he went, and many of these are still in existence.

At Kiel his collection is in glass-topped trays, the tops being loose in many cases. The trays are in two large cases, one occupied almost entirely by beetles, while the Hymenoptera and some other orders fill the other.

The two groups named, at least, are in fair condition, and the Hymenoptera are arranged to correspond with the Systema Piezatorum. Each genus has a special label, bearing besides the name, the number of the genus, as given in the Systema, and each species is preceded by a similar label giving the name and number of the species. In some cases the insect itself is missing though the label is present, and some numbers are also absent, probably because the book enumerated species he had seen and described, but which he himself did not have.

Probably the next largest collection of Fabrician material is now in the British Museum of Natural History in London, and is known as the Banksian Collection. This material was obtained by Mr. (afterwards Sir Joseph) Banks and Dr. Solander, who accompanied the celebrated Captain Cook in his voyage to the South Sea Islands and around the world, from 1768 to 1771. It was studied by Fabricius between 1772 and 1775 and the new species were published by him in 1775 in his Systema Entomologiæ and are indicated by the words "*Mus. Bankianum,*" or in his later writings by the words "Mus. Dom. Banks." This collection was for years in the hands of the Linnaean Society, but is now in the British Museum

where most fortunately it is preserved as a separate collection bearing the original Fabrician labels, thus giving us Fabricius' ideas of the old species even where they are not his types.

They have been worked over somewhat since, not always fortunately, and some care must be exercised to be sure of all the labels. Thus Frederick Smith in his Catalogue of the Hymenopterous Insects in the British Museum records *Sphex pensylvanicus* L. as being in this collection. An examination of the specimen shows the unquestionable Fabrician label "*pennsylvanica*" and above it a much more recent label, "Pennsylvania" written by Smith, to judge from the hand writing. So close to the underside of the body as to be easily overlooked, is a third and very old label reading "Nov. Holl." Now as Captain Cook on the voyage during which these insects were collected, did not touch at any point in North America, it is evident that Fabricius named the insect entirely from its appearance, without reference to the locality where it was captured, and Smith, probably failing to notice the upper label, added a locality label of his own preparation to agree with the name. An interesting feature of the case is that Fabricius wrongly identified the specimen, which is not *pensylvanica* at all, but *fumipennis* of Smith, described by the latter from other material, in the same book in which he records this insect in the Banksian collection, evidently failing to recognize the identity of the two. An occasional case like this indicates that care in the study of this collection is indispensable.

The National Museum at Paris also contains some specimens named by Fabricius. What remains of the Bosc collection is there, and Fabricius frequently records species from the "Mus. Dom. Bosc." which apparently came into the hands of the National Museum at the death of Bosc in 1828. This material is much scattered, however, and can only be recognized by labels in the hand of Fabricius and the others which read "Museum Paris Coll Bosc 1828" printed on green paper and which were undoubtedly added when the collection became the property of the Museum.

The collection of Klug is in the Zoological Institute of the University of Berlin. It is not kept separate but has been worked into the general collections and can now be recognized only by the labels. These are on green paper and bear the

specific name, beneath which is a capital N and at the bottom the locality, all enclosed by a black line. Frequently the middle of the left side of the label has a slit cut in, so that it might slip around the pin instead of being penetrated by it. In some cases the label has been closely trimmed, but comparison of the writing with that on the entire ones, is sufficient to establish its identity.

Klug seems to have been more liberal with names on museum specimens than with published descriptions of these species, at least in the Hymenoptera. Apparently later workers in some cases found the names Klug had given to the specimens and published them, adopting names which would otherwise have no standing. Erichson seems to have done this in one case at least, and Dahlbom in several.

Though the collection of Dahlbom is at the University of Lund, his work is to some degree in evidence at Berlin where he studied for a time with Klug, and specimens named by him are frequently met with there. His own collection at Lund is kept by itself in the condition in which he left it and for the most part in a good state of preservation.

In the Paris Museum a few specimens which seem to have been labeled by Latreille are still preserved. These labels have double red line borders and the names which are hand-printed are, first the French name, and beneath this the Latin one, the two being bracketed together on the right, beyond which is the abbreviation "Latr." In some cases at least, these names do not appear to have been published and therefore have no standing.

A few boxes of Hymenoptera in this collection are marked "Brullé Collection" on the outside, so that some of Brullé's species at least, are still in existence.

The Lepelletier collection is in much the same condition and some boxes bear the label "Lepelletier Collection." In these the material named by him is probably indicated by names written in red ink between parallel red lines on the labels. Unfortunately many of his species are missing, and in the case of the *Sphecidæ* none of his American species can be found. Whether they have been accidentally destroyed, or, most of them being from Serville, were returned and later were lost, cannot now be determined.

Though not one of the old collections, that of Achille Costa may be mentioned. This is now at the University of Naples, where it is kept in a room by itself. There is no entomologist at the University and the collection is in charge of the Professor of Parasitology, but it is in excellent condition and apparently well cared for.

Many other old collections may be found in different parts of Europe, but not having paid particular attention to them they are not touched upon here. It is noticeable nearly everywhere that these collections are for the most part kept in trays so open that in this country a single year would probably see their complete destruction by museum pests. These nuisances do not appear to be very important abroad or the priceless collections of Linne, Fabricius and others would long ago have become mere heaps of dust at the bases of the pins.

Discussion.

Dr. Howard said in discussion that there is so much of value in information of the character of that contained in Dr. Fernald's paper, that he was emboldened to add two statements: First, that the bulk of the collection of A. H. Haliday, the brilliant Irish entomologist, is now carefully preserved by Prof. G. H. Carpenter in the College of Agriculture, in Dublin; Second, that the Ratzeburg types are preserved like religious relics by Dr. Eckstein at the forest school at Ebersiwalde bei Berlin.

THE ENTOMOLOGICAL SOCIETY OF AMERICA.

Organized 1906.

OFFICERS FOR 1914.

President.

PHILIP P. CALVERT.....University of Pennsylvania, Philadelphia, Pa.

First Vice-President.

JAMES G. NEEDHAM.....Cornell University, Ithaca, N. Y.

Second Vice-President.

C. GORDON HEWITT.....Dominion Entomologist, Ottawa, Canada.

Secretary-Treasurer.

ALEX. D. MACGILLIVRAY.....University of Illinois, Urbana, Ill.

ADDITIONAL MEMBERS OF EXECUTIVE COMMITTEE.

HERBERT OSBORN, Ohio State University, Columbus, O., *ex officio.*
WILLAIM M. WHEELER, Harvard University, Cambridge, Mass.
VERNON L. KELLOGG, Leland Stanford Jr. Univ., Stanford Univ., Calif.
NATHAN BANKS, United States National Museum, Washington, D. C.
E. P. FELT, State Entomologist, Albany, N. Y.
J. M. ALDRICH, U. S. Bureau of Entomology, Lafayette, Ind.

COMMITTEE ON NOMENCLATURE.

H. T. FERNALD, Massachusetts Agric. College, Amherst, Mass., 1914.
E. P. FELT, State Entomologist, Albany, N. Y., 1915.
T. D. A. COCKERELL, University of Colorado, Boulder, Col., 1916.

COUNCILORS FOR THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

PHILIP P. CALVERT, University of Pennsylvania, Philadelphia, Pa.
CHARLES J. S. BETHUNE, Ontario Agric. College, Guelph, Ontario.

EDITORIAL BOARD OF ANNALS.

HERBERT OSBORN, Managing Editor, Ohio State Univ., Columbus, O.
J. H. COMSTOCK, Cornell University, Ithaca, N. Y., 1914.
CHARLES J. S. BETHUNE, Ontario Agric., College, Guelph, Ontario, 1914.
C. W. JOHNSON, Boston Society of Natural History, Boston, Mass.,1914.
VERNON L. KELLOGG, Leland Stanford, Jr., Univ., Stanford Univ., Cal., 1914.
L. O. HOWARD, Chief, Bureau of Entomology, Washington, D. C., 1914.
W. M. WHEELER, Harvard University, Cambridge, Mass., 1914.
PHILIP P. CALVERT, University of Penn., Philadelphia, Penn., 1914.
J. W. FOLSOM, University of Illinois, Urbana, Ill., 1914.

RESOLUTIONS.

On the Death of Philip Reese Uhler.

Dr. Philip Reese Uhler, L. L. D., Provost of the Peabody Institute, Baltimore, Maryland, died October, 21, 1913.

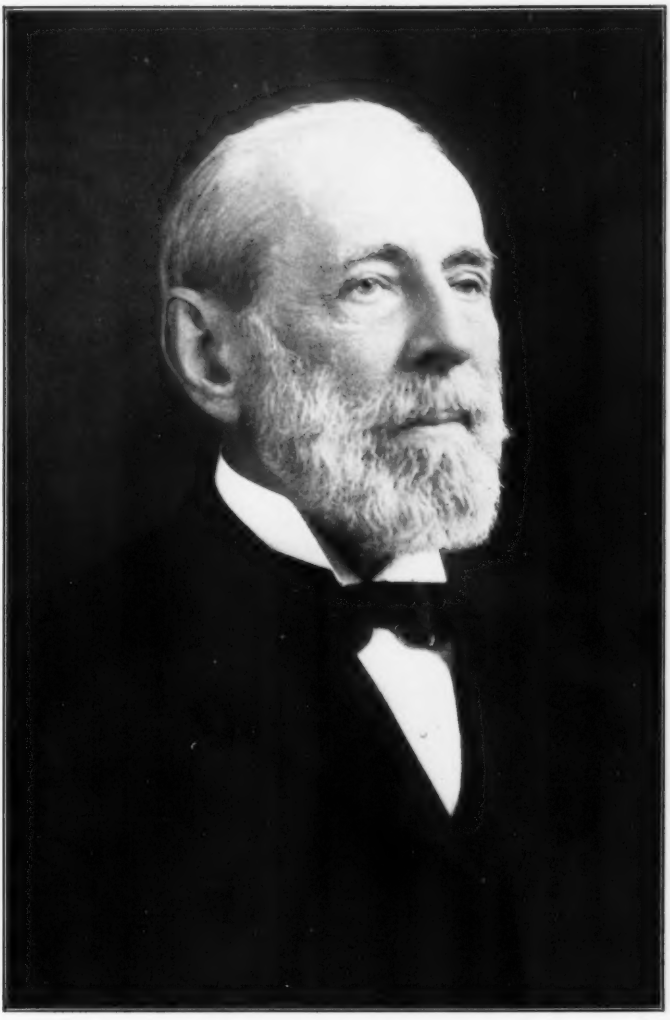
Dr. Uhler was an honorary fellow of the Entomological Society of America, one of the first to be distinguished by such election and was recognized as one of the most eminent entomologists of the country. His contributions, especially to our knowledge of the Hemiptera, were of great extent and form the basis for the study of this group in America and have had no small influence upon the development of the subject in the world at large. They will stand as an enduring monument to his industry, skill and keen insight as a systematist.

Along with the high qualities of his scientific work he had a most engaging personality and his memory will be cherished by all who had the good fortune to secure his friendship.

He was a man of true scientific spirit and enthusiasm, a lover of the fields and woods, an expert collector, and most generous in his aid to his fellow workers.

Recognizing the permanent value of his contributions to entomology and also the high character and worth of the individual, the members of the Entomological Society of America desire to place on record in an enduring manner its sense of appreciation for the man and his work and it is hereby resolved that this testimonial be spread upon the minutes of the Society and printed in the Annals.

Committee Herbert Osborn
Philip P. Calvert,
J. H. Comstock.



PHILIP REESE UHLER, LL. D.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA.

Atlanta Meeting.

The Eighth Annual Meeting of the Entomological Society of America was called to order by Dr. Philip P. Calvert in the absence of the President, Rev. Charles J. S. Bethune, at 10:00 A. M., Tuesday, December 30th, in the rooms of the Physiological Department of the Atlanta Medical College. In calling the meeting to order Dr. Calvert conveyed to the Society Dr. Bethune's deep regret at being unable to be present and his hearty good wishes for its success. The meetings were all well attended, the number was surprising considering Atlanta's isolation from great educational centers. The following committee, appointed by President Bethune, was named:

Committee to draft resolutions on the death of Dr. Philip Reese Uhler.—Herbert Osborn, J. H. Comstock, and Philip P. Calvert.

The chair was directed by motion to appoint the following committees: Committee on Resolutions; Committee on Nominations; Auditing Committee.

The following papers were then read, but through the action of the Executive Committee that all abstracts should be omitted from the proceedings, only titles are given:—

J. T. Lloyd, Cornell University—The structure of the hind intestine of *Corydalis*.

Paul S. Welch, Kansas Agricultural College—Observations on the habits and life-history of *Hydomyza confluens* Loew. Read by title.

Stanley B. Fracker, University of Illinois—New characters in the classification of microlepidopterous larvæ.

Cornelia F. Kephart, Cornell University—The poison glands of *Euproctis chrysorrhoea* Linn. Presented by W. A. Riley.

N. L. Partridge, University of Illinois—The tracheation of the anal area of the wings of the Lepidoptera and the homology of the veins. Read by title.

Herbert Osborn, Ohio State University—The box-elder bug in Ohio.

V. E. Shelford, University of Chicago—The elytral tracheation of the subfamilies and genera of Cicindelidæ.

Edna Mosher, University of Illinois—Some interesting structures in the pupæ of Lepidoptera.

W. A. Riley, Cornell University—Some sources of error in the interpretation of insect tissue.

J. S. Houser, Ohio Agricultural Experiment Station—*Conwentzia hageni* Banks, life-history notes and variations in wing venation.

Alvah Peterson, University of Illinois—Notes on the head-structures of Thysanoptera. Read by title.

Philip P. Calvert, University of Pennsylvania—The desirability of a biographical dictionary of entomologists.

The President announced the following Committees:—

Committee on Resolutions—F. L. Washburn, Henry Skinner, and J. G. Sanders.

Committee on Nominations—W. A. Riley, P. J. Parrott, and G. M. Bentley.

Auditing Committee—T. J. Headlee, H. T. Fernald, and R. H. Pettit.

The Society then adjourned to meet at 2:00 P. M. The afternoon was devoted to a joint meeting of Section F of the American Association for the Advancement of Science and of the Entomological Society of America at which the following papers were presented:—

L. O. Howard, United States Entomologist—Note on the present status of the Gipsy Moth parasites in New England.

E. L. Worsham, State Entomologist of Georgia—Some notes regarding the natural history of the mole cricket.

H. T. Fernald, Massachusetts Agricultural College—Notes on some old European collections.

P. J. Parrott, W. O. Gloyer and B. B. Fulton, New York Agricultural Experiment Station—Studies on the Snowy Tree-cricket, *Oecanthus niveus*, with reference to apple bark diseases. Presented by P. J. Parrott.

J. Chester Bradley, Cornell University—Collecting insects in the Okefenoke swamp. Presented by J. G. Needham.

Herbert Osborn, Ohio State University—Studies on the geographical distribution of leaf-hoppers, especially of Maine.

Philip P. Calvert, University of Pennsylvania—The fauna of the epiphytic bromeliads in Costa Rica.

The Society adjourned at 4:45 P. M., to meet Wednesday, December 31st, at 9:30 A. M.

The annual business meeting of the Society was held upon reconvening and the following reports were presented:—

The committee appointed to draft resolutions on the death of Dr. Philip Reese Uhler presented its report. It was ordered accepted and printed.

The Secretary presented the following report for the Executive Committee, which met at the Hotel Ansley, Tuesday evening. Dr. W. M. Wheeler and Dr. Henry Skinner were named as additional members of the committee. Dr. Skinner sat with the committee.

REPORT OF THE EXECUTIVE COMMITTEE.

The following matters were considered in the interim since the last Annual Meeting:—

The appointment of Dr. E. P. Felt to give the Annual Public Address at the Atlanta meeting.

A request from the Secretary that the President be given permission to call for the election of a sufficient number of persons to make a quorum of the Executive Committee at the Atlanta meeting in case there were not four members in attendance.

Mr. Nathan Banks presented a request from the International Committee on Nomenclature of the Second International Congress of Entomology, that this society should name two members to serve on the American National Committee. President Bethune named as representatives, Dr. E. P. Felt and Dr. H. T. Fernald.

Mr. A. W. Baker, Secretary of the Entomological Society of Ontario, presented a request that the Entomological Society of America should send a delegate to its Jubilee meeting, the fiftieth annual meeting, to be held at the Ontario Agricultural College, Guelph, Wednesday, Thursday, and Friday, August 27 to 29. The President named the Secretary as the representative of the Society. Your Secretary had the pleasure of attending these meetings. He had the most delightful time, intellectually and socially, of any scientific meeting that he has attended. There were delegates present from England, Scotland, United States, and Canada.

The following new members were elected June 1, 1913:

W. C. Allee.	David Gunn.
Frank M. Gibson.	H. A. Horton.

The following members have died during the year:

D. F. Berrenger.	Charles W. Hooker.
A. G. Hammar.	J. M. Shaffer.

P. R. Uhler.

The following resignations were presented and accepted:

Otto Bucholz.
Fred Johnson.
C. A. Shull.
P. E. Smith.
R. I. Smith.
Anna C. Stryke.
A. G. Vestal.

The names of thirteen members were dropped from the rolls for non-payment of dues.

The following new members were elected by the Executive Committee at its meeting last evening:—

L. C. Barber.
G. T. Bethune-Baker.
S. W. Bilsing.
M. W. Blackman.
Josef Bruner.
R. E. Campbell.
Leroy Child.
E. S. Cogan.
W. M. Davidson.
G. A. Dean.
H. F. Dietz.
W. D. Edmonston.
W. O. Ellis.
J. B. Gill.
J. E. Graf.
T. E. Holloway.
J. R. Horton.
H. L. Johnson.
Cornelia F. Kephart.
R. J. Kewley.
F. H. Lathrop.
Philip Luginbill.
F. L. McDonough.
R. S. McDougall.
J. R. Malloch.
W. M. Mann.
E. A. McGregor.
Ximena McGlashan.
J. D. Mitchell.
L. J. Nickels.
F. B. Paddock.
Phil. Rau.
E. A. Richmond.
L. P. Rockwood.
James Sinclair.
M. P. Somes.
Dayton Stoner.
D. T. Stevens.
T. J. Talbert.
J. D. Tothill.
C. T. Vorhies.
Otis Wade.
J. R. Watron.
H. B. Weiss.
G. M. Wendelken.
F. X. Williams.
T. S. Wilson.
H. P. Wood.
W. C. Woods.
M. A. Yothers.

The total membership of the Society as reported at the Seventh Annual meeting was 410, deducting the names of the persons who have died during the year, resigned, or dropped by the Secretary and adding the names of the new members elected in June and at this meeting, the membership is now 439.

The Secretary was instructed to prepare a small booklet describing the origin of the Society and its aims, as an aid in further extending the membership.

The first suggestion of a national entomological society was presented at the last Philadelphia meeting in 1904, of the American Association for the Advancement of Science. Dr. Henry Skinner was asked by the Executive Committee to prepare a history of the Entomological Society of America to be read at the Eighth Annual Meeting.

TREASURER'S REPORT.

RECEIPTS.

Cash on deposit in the First National Bank of Champaign, Illinois, December 9, 1912	$ 40.87
Life Membership Fees deposited with the Cleveland Trust Company, Cleveland, Ohio, September 18, 1912	100.00
Life Membership Fee of W. T. M. Forbes deposited with the Cleveland Trust Company, of Cleveland, Ohio, September 18, 1913	50.00
Interest on Fees of Life Members, July 1, 1913	4.37
Cash received from Herbert Osborn, Managing Editor of the Annals	252.86
Cash collected as dues	726.09
	$1,144.19

BALANCE.

Bills paid:		
Annals and separates for December, 1912	$377.47	
Annals and separates for March, 1913	332.25	
Engraving bills paid by the Treasurer	66.09	
Stamps and Stamped envelopes	27.62	
Printing for the Secretary-Treasurer's office	28.03	
Stenographer	20.25	
One-half guarantee on Cleveland smoker	3.67	
Check refused by bank	2.00	
		$857.38
Life Membership Fees deposited with the Cleveland Trust Company, Cleveland, Ohio, December 8, 1913		150.00
Interest on Fees of Life Members deposited with Cleveland Trust Company, Cleveland, Ohio, December 8, 1913		4.37
Cash on deposit in the First National Bank of Champaign, Illinois, December 8, 1913		132.44
		$1,144.19

Dr. C. Gordon Hewitt, Provincial Entomologist of Canada and Dr. William Barnes, Lepidopterist of Decatur, Illinois, were elected Fellows of the Society.

It was voted, that in the future no abstracts of the papers presented at the Annual Meeting should be included in the printed proceedings of the meeting.

The following amendment to Article IV, Section 2 of the Constitution was recommended, which reads:

Article IV, Section 2. The business of the Society not otherwise provided for shall be in the hands of an Executive Committee, consisting of the officers named in Section 1, and of six additional members, five of whom shall be elected from the Fellows by the Society, and the sixth shall be *ex officio* the Managing Editor. Four members of the Committee shall constitute a quorum.

To be amended to read:

Article IV, Section 2. Executive Committee.—The business of the Society not otherwise provided for shall be in the hands of an Executive Committee, consisting of the officers named in Section 1, and of six additional members, five of whom shall be elected from the Fellows by the Society, and the sixth shall be *ex officio* the Managing Editor.

There shall be a meeting of the Executive Committee at each Annual Meeting. Four members shall constitute a quorum and in the case of the non-attendance of this number at any Annual Meeting, the Society shall elect a sufficient number from among the Fellows in attendance to complete the quorum.

On motion the report of the Executive Committee was adopted.

REPORT OF THE MANAGING EDITOR OF THE ANNALS.

The Editor begs leave to report for the past year the following items:

RECEIPTS.

Subscriptions	$170.60
Back Numbers	81.91
Authors Reprints	70.00
	$323.11

EXPENDITURES.

Engravings	$52.80
Postage	9.65
Stenographic Help	7.80
Paid Treasurer	252.86
	$323.11

The volume for the year, which includes about five hundred pages and fifty-nine plates, will I believe maintain the quality of preceding volumes and it has been necessary to postpone or refuse other papers of excellent quality because of the lack of funds for further publication. It is hoped that the income for the coming year will permit the handling of a number of these papers but the Editor believes that the amount printed should be kept within the margin of receipts and if possible no deficit be created. The sale of a few sets of back volumes would assist much in the publication of additional matter and any assistance in placing such sets will be very much appreciated.

The Editor desires to express his appreciation of the aid rendered by the members of the Editorial Board, and to the Secretary for his untiring efforts in attending to the details of the business falling to his office.

Respectfully submitted,

HERBERT OSBORN,
Managing Editor.

REPORT OF THE AUDITING COMMITTEE.

Your Auditing Committee presents herewith its report. We have examined the books of the Treasurer for the year ending December 8, 1913, and find them to be correct. We have also examined the accounts of the Managing Editor of the Annals and find them to be correct.

Signed, THOMAS J. HEADLEE,
H. T. FERNALD,
R. H. PETTIT.

REPORT OF THE COMMITTEE ON NOMINATIONS.

Your committee begs leave to report the following names as nominees for the respective offices for 1914:—

OFFICERS.

President: Philip P. Calvert, University of Pennsylvania, Philadelphia, Pa.

First Vice-President: James G. Needham, Cornell University, Ithaca, N. Y.

Second Vice-President: C. Gordon Hewitt, Provincial Entomologist, Ottawa, Canada.

Secretary-Treasurer: Alex. D. MacGillivray, University of Illinois, Urbana, Ill.

ADDITIONAL MEMBERS OF EXECUTIVE COMMITTEE.

Herbert Osborn, Ohio State University, Columbus, Ohio, *ex officio.*

William M. Wheeler, Harvard University, Cambridge, Mass.

Vernon L. Kellogg, Leland Stanford Jr., University, Stanford University, Cal.

Nathan Banks, United States National Museum, Washington, D.C.

E. P. Felt, State Entomologist, Albany, N. Y.

J. M. Aldrich, United States Bureau of Entomology, Lafayette, Ind.

MEMBER OF COMMITTEE ON NOMENCLATURE.

T. D. A. Cockerell, University of Colorado, Boulder, Colorado.

Signed, W. A. RILEY,
P. J. PARROTT,
G. M. BENTLEY.

On motion, the Secretary was instructed to cast a ballot for the officers named and they were declared elected.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

The Committee on Resolutions beg leave to submit the following:—

Resolved, That the Entomological Society of America hereby express their appreciation of the various courtesies extended to them at this meeting by the city of Atlanta, by Governor and Mrs. Slaton, by the University and Capital City clubs, by the Atlanta Medical College, and by the local Press.

Resolved, That its thanks are also due the Atlanta Chamber of Commerce for its hearty co-operation with the University Club and the Atlanta Convention Bureau through whose efforts the meeting at Atlanta was made possible; and further

Resolved, That our thanks are especially due and are hereby extended to the local Executive Committee and Mr. E. L. Worsham for their painstaking and effective efforts in behalf of the convention.

Signed, F. L. WASHBURN,
HENRY SKINNER,
J. G. SANDERS.

The Committee on Nomenclature presented an informal report which was ordered accepted.

REPORT OF THE COMMITTEE ON ENTOMOLOGICAL TYPES.

One of us (Cockerell) examined the collections of the U. S. National Museum and the Carnegie Museum during the year. The types, so far as seen, were found in excellent condition, but not all in systematic order or available for study and comparison without some searching. We know of no museum in which the entomological staff is really adequate. At the Carnegie Museum one is amazed at the richness and value of the collections, including materials which have been described in many important memoirs, and enormous numbers of specimens not yet worked over, but evidently including much of interest. The entomological curator has succeeded in keeping everything in good condition, but it would take a considerable staff of workers to put the collections all in order and keep the accessions worked up. At the U. S. National Museum one finds a large staff of well-known entomologists, many of whom work over time and on holidays in the effort to keep the collections in order and work up the accessions. However, the appearance of an adequate entomological staff is illusory, since nearly all of the men belong to the Bureau of Entomology of the Department of Agriculture, and have to give their attention to economic problems and routine work of various kinds. Judging by the large amount of published work issued from the Museum, one might suppose the number of workers to be sufficient, but this idea is soon dispelled on examining the very large and important collections remaining unstudied and noting the continued stream of accessions. The scientific staff of the National Museum is inadequate in almost all departments, but especially in Entomology, a subject which covers a much greater and more important field than the public imagines. The type problem becomes part of the general problem of securing adequate and competent curatorial assistance; not only for the proper care and availability of the types already owned by the Museum, but also and especially in regard to obtaining other types. The study and description of the new species now in the Museum would add thousands of types to the collection; while many private workers would give or leave their types to the institution, were entomology treated by Congress and the authorities as it deserves.

We think, therefore, that all entomologists should make a point of urging, whenever possible, the claims of their science to a larger share of support in important Museums. In doing this, they may properly point out the astonishing revelations of recent years in regard to the importance of various insects to man, showing that a knowledge of entomology is of prime importance for the progress of civilization. They may also point out that in the case of large public museums, all the major expenses have been met, and it is only necessary to add a comparatively small amount to greatly increase the scientific output.

Several workers in the National Museum recently agreed with the suggestion that 5% of the total expenditure on the Museum, added to the cost of maintaining the scientific departments, would double the scientific out put.

Signed, T. D. A. COCKERELL,
L. O. HOWARD,
HENRY SKINNER.

On motion, the report was ordered accepted and printed and the Committee continued for another year.

REPORT OF THE SPECIAL COMMITTEE ON HOLDING A SUMMER MEETING ON THE PACIFIC COAST IN 1915.

Your committee desires to report that there seems to be a strong sentiment in favor of holding a summer meeting on the Pacific coast in 1915.

It finds the officers of the Panama-Pacific International Exposition willing to co-operate in every reasonable manner, and it is informed that the meeting can be held on the exposition grounds or at either Stanford University or at the University of California. One member of the Committee suggests the desirabliity of a group of entomologists traveling together and arranging to have a field meeting at some Rocky Mountain point. There would probably be no difficulty in arranging for the necessary stop over privileges.

The western entomologists will be enthusiastic supporters of such a gathering and it should be attended by a number of eastern men. We feel it highly desirable to have such a meeting and therefore recommend that arrangements be consumated. We respectfully suggest including in the nominations for 1915, at least one vice-president who would be in position to serve as chairman of the meeting in case a president was unable to attend.

Signed, E. P. FELT, W. M. WHEELER,
V. L. KELLOGG, T. D. A. COCKERELL,
A. J. COOK.

On motion, the report was ordered accepted and printed and the committee was ordered continued as a Committee on Arrangements with the addition of Dr. E. C. Van Dyke of the University of California.

The following amendments to the Constitution submitted at the Cleveland meeting of the Executive Committee were read:—

Article IV, Section 3. The President shall represent the Society upon the Council of the American Association for the Advancement of Science until such time as the Society shall be qualified for representation by two councilors, in which case the second councillor shall be elected from the Fellows by the Executive Committee.

To be amended to read as follows:

Article IV, Section 3. Councillors to the American Association. The President and the preceding Past-President shall represent the Society upon the Council of the American Association for the Advancement of Science. In case of the death or resignation of either or both councillors, the vacancy shall be filled by the Executive Committee.

Article V, Section 3. Election of Officers. All officers shall be elected by ballot at the Annual Meeting for the term of one year and shall be eligible for re-election. The term of their office shall commence with the first of June following their election.

To be amended to read as follows.

Article V, Section 3. Election of Officers. All officers shall be elected by ballot at the Annual Meeting for the term of one year and shall be eligible for reelection.

On motion, the amendments were adopted.

The Executive Committee at the Cleveland meeting submitted the following addition to the Constitution:

ARTICLE VII.

SECTION 1. Publication.—The official publication of the Society shall be known as the Annals of the Entomological Society of America. Each volume shall consist of four fascicles and the first fascicle of each volume shall contain the proceedings of the Annual Meeting.

SECTION 2. Editorial Board.—The publication shall be under the charge of an Editorial Board consisting of ten members, one of whom shall be the Managing Editor. The Managing Editor and his associates shall be responsible for the selection of the material to be published.

SECTION 3. Election of Editorial Board.—The members of the Editorial Board shall be elected by the Executive Committee. Each member of this board, excepting the Managing Editor, shall serve for three years or until his successor has been elected, three members retiring annually.

SECTION 4. Report Managing Editor.—The Managing Editor shall present a report at each Annual Meeting to the Executive Committee and the accounts of his office shall be reported upon by the Auditing Committee.

On motion, this additional article to the Constitution was adopted.

Mr. H. H. Lyman read a letter from President Bethune expressing his regret at being unable to be present at the meeting.

On motion, the Secretary was instructed to send a Night Letter to President C. J. S. Bethune, extending greetings from the Society, their pleasure on the recovery of his sight, and their regret at his inability to attend the meetings.

The following communication submitted to the Secretary by Mr. Nathan Banks was read:—

Inasmuch as there is no independant society in this country able to publish large works on Entomology, and since there are even now manuscripts awaiting printing, and with time there will be more, I suggest that the Entomological Society of America found such a society. This Society to be known as "The Thomas Say Society." Its object to publish catalogues, revisions, and monographs of North American insects. That it be authorized to solicit and collect money for a permanent fund, the interest on which shall be used for the printing of said works. That the Society shall be controlled by a board of five entomologists, chosen by the Executive Committee of the Entomological Society of America. Each member to serve five years, the first board to have one member for one, two, three, four, and five years, thereafter one selected each year. That all money received for sale of publications be added to the permanent fund. That said board of control shall select whatever officers they deem necessary and have authority for accepting articles for printing and disbursement of funds.

On motion, the President was directed to appoint a committee of three to consider ways and means for the establishment of such a society. The President appointed the following committee:—Nathan Banks, Chairman, H. H. Lyman, and Morgan Hebard.

The following papers were then read:—

James Zetek, Panama Canal Zone—The dispersal of *Musca domestica*.

William Moore, University of Minnesota—A comparison of the enemies of *Toxoptera graminum* in South Africa and the United States. Presented by F. L. Washburn.

Robert Matheson, Cornell University—Life-history notes on *Psephenus lecontei* and *Hydroporus septentrionalis*. Read by title.

V. E. Shelford, University of Chicago—The sequence of color changes during ontogeny in *Cicindela*.

R. W. Leiby, Cornell University—Notes on the external anatomy of some Pentatomidæ.

L. S. Barber, Florida State College for Women—The biology of *Gelechia gallæsolidaginis* with some reference to some of its parasites.

A. F. Conradi, Clemson College—A little known wireworm, *Horistonotus uhleri.*

Leonard Haseman, University of Missouri—The life-history of a species of Psychodiæ. Read by title.

A. D. MacGillivray, University of Illinois—The Structure of the thorax in generalized insects.

James Zetek, Panama Canal Zone—Behavior of *Anopheles tarsimaculata* Goldi. Read by title.

J. T. Lloyd, Cornell University—Life-history of *Elophila magnificalis,* an aquatic lepidopteron. Read by title.

The following exhibits were shown:—

J. S. Houser, Ohio Agricultural Experiment Station—*Conwentzia hageni* Banks, a coniopterygid.

E. L. Worsham and J. Chester Bradley, Office State Entomologist of Georgia—Collections of Coleoptera and Odonata from Georgia belonging to Georgia State Board of Entomology.

J. Chester Bradley, Cornell University—Photographs of the Okefenoke swamp.

S. B. Fracker, University of Illinois—Setæ of microlepidopterous larvæ.

James Zetek, Panama Canal Zone—Blue-print upon which was shown the more important data obtained in the study of the behavior of *Anopheles tarsimaculata* Goldi.

The Annual Public Address of the Society was given on Wednesday evening, December 31st, at the Atlanta Medical College by Dr. Ephraim Porter Felt, State Entomologist of New York, on the Subject of Gall Insects.

A smoker for the entomologists and zoologists in attendance at the meetings was held at the University Club on Thursday evening January 1st, Mr. E. L. Worsham and the staff of the State Entomologists office acting as hosts.

On motion, the Society adjourned to meet in one year with the American Association for the Advancement of Science, at Philadelphia, Pennsylvania.

ALEX. D. MACGILLIVRAY,
Secretary.